A new methodological approach to assess drug driving –

The German Smartphone Survey

Inaugural-Dissertation

zur Erlangung der Doktorwürde der

Philosophischen Fakultät II

der Julius-Maximilians-Universität Würzburg

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2012

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Tag des Kolloquiums: 23.10.2012

ACKNOWLEDGEMENTS

The present piece of work would not have been possible without the support of several people who contributed with ideas, conversations, guidance and care: my sincerest thanks to everybody who helped me through this project.

First of all, I would like to thank my doctoral adviser Prof. Dr. Hans-Peter Krüger for giving me the chance and for having the confidence in me to be responsible for conducting the German smartphone survey (GSS). The study was carried out at the Center for Traffic Sciences (IZVW) in Wuerzburg, Germany, and was part of the DRUID project (Driving under the Influence of Drugs, Alcohol and Medicines). Therein, the study was implemented in Work Package 2 "Epidemiology". DRUID was financed by the European Community within the EU 6th Framework Program and coordinated by the Federal Highway Research Institute in Germany ("Bundesanstalt für Straßenwesen", BASt).

By being responsible for this work, I had the opportunity to acquire much worthwhile experience and to work together with many great people. I extend special thanks to the whole project team of BASt, in particular Dr. Horst Schulze, Dr. Anja Knoche and Dr. Raschid Urmeew for the good cooperation and for being host of all the fruitful project meetings. I would also like to thank Inger Marie Bernhoft, in her position as Work Package Leader, for the good cooperation within the project. Furthermore, I would like to thank Prof. Dr. Mark Vollrath for his interest in my work and for agreeing to act as second supervisor.

Thanks to all of my colleagues and friends at the IZVW for the warm and open working atmosphere. A special thanks goes to Dr. Volker Hargutt ("the chief") for his constant support, his encouraging words and his brilliant ideas. A problem shared is a problem halved – that is why I want to say a big thank you to Dr. Eva Schnabel, my close friend and fellow sufferer. Without her, this work would never have been completed in such a pleasant manner. I thank her for her good advise whenever I needed it. I want to thank Susanne Gesell for supporting the study at its peak and Florian Fischer for his patience concerning the technical setup of the study. Thanks to Lorenz Wohanka, Gabriel Schmidt, Elisabeth Kaminski, Bettina Reuchlein, Simon Renner, Katharina Wiedemann, Julia Messerschmidt and Florian Weber for helping as student assistants – as busy as bees – at all stages of data collection and data preparation. Thanks to Heidi Grattenthaler for her good advise and her open ear during breaks, to Fred Naujoks for the just-in-time supply with cappuccinos and ice cream, to Ingo Totzke for his biting humour, to Marcus Schmitz for organising activities outside of work and to Dominik Mühlbacher and Sebastian Will for making sure that physical activity is not missed out at work.

Thanks to Pamela Watzal and Ralph Thees for assisting me with their experience and expertise in media relations. In addition, thanks to all journalists who publicised the GSS (as *do**you**DRUGDRIVE?*-study) for recruitment purposes. I also want to say thanks to Alexander Pabst from IFT ("Institut für Therapieforschung") and Katja Köhler from DLR ("Deutsches Zentrum für Luft- und Raumfahrt") for assisting in using the ESA (Epidemiological survey on substance abuse among adults in Germany) and MiD (Mobility in Germany) data, respectively.

A very special thanks goes to all persons who participated in the study as subjects for their trust and good compliance.

Last but not least, I would like to express my gratitude for the assistance and patience of my family and close friends who always believed in me and always encouraged me during the past few years. Thank you very much!

LIST OF ABBREVIATIONS

AES: Advanced Encryption Standard
ARSB: Austrian Road Safety Board (“Kuratorium für Verkehrssicherheit“, KVF)
ART2020: Act & React Test System 2020 Standard test battery
ASP.NET: Active Server Pages .NET
BAC: Blood alcohol concentration
BASt: Federal Highway Research Institute, (“Bundesanstalt für Straßenwesen”)
BE: Belgium
BES: BlackBerry Enterprise Server
BtMG: Controlled Substances Act (“Betäubungsmittelgesetz”)
CZ: Czech Republic
DK: Denmark
DLR: Germany's national research center for aeronautics and space (“Deutsche Zentrum für Luft- und Raumfahrt“)
DRUID: Driving Under the Influence of Drugs, Alcohol and Medicines
DUI: Driving under influence
ES: Spain
ESA: Epidemiological survey on substance abuse among adults in Germany (“Sucht-survey”)
ETSC: European Transport Safety Council
FeV: German Driver Licensing Act (“Fahrerlaubnisverordnung“)
FIN: Finland
GSS: German Smartphone Survey
HU: Hungary
IFT: Research institute in Munich, Germany, with a main focus on substance use disorders (“Institut für Therapieforschung“)
IIS: Internet Information Server
IT: Italy
IZVW: Center for Traffic Sciences in Wuerzburg, Germany (“Interdisziplinäres Zentrum für Verkehrswissenschaften”)
LT: Lithuania
MDS: Mobile Data Services
MiD: Mobility in Germany (“Mobilität in Deutschland”)
MPA: Medicinal and psychological assessment
N: Norway
NL: The Netherlands
PL: Poland
PT: Portugal
RIM: Research in Motion
SCID-I: Structured Clinical Interview for DSM-IV Axis I Disorders (“Strukturiertes Klinisches Interview für DSM-IV Achse I Störungen”, SKID-I)
SE: Sweden
StGB: German Penal Code (“Strafgesetzbuch“)
StVG: German Road Traffic Act (“Straßenverkehrsgesetz“)
THC: delta-9-tetrahydrocannabinol

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ZUSAMMENFASSUNG

Ziel der vorliegenden Arbeit war es, Informationen über das Vorkommen von Fahrten unter Substanzeinfluss in Deutschland und über Prädiktoren für das Auftreten von Drogenfahrten bereitzustellen. Die im folgenden dargestellte Studie liefert diesbezüglich aufschlussreiche Befunde, die sowohl die wissenschaftliche Diskussion anregen als auch von praktischem Nutzen für Rehabilitations- und Präventionsmaßnahmen sein können.

Für Deutschland sind in regelmäßigen Abständen repräsentative Daten über den Konsum psychoaktiver Substanzen (Epidemiologischer Suchtsurvey 2006 – ESA 2006; Kraus, Pfeiffer-Gerschel & Pabst, 2008) und das Mobilitätsverhalten (Mobilität in Deutschland – MiD 2008; http://www.mobilitaet-in-deutschland.de) erhältlich. Was allerdings bis heute fehlt, ist die Verknüpfung beider Datenbestände, um daraus detaillierte Informationen über Fahrten unter Substanzeinfluss in Deutschland zu erhalten.

Um diese Informationslücke zu schließen, wird mit der vorliegenden Studie ein neuer methodischer Ansatz zur Erhebung von Daten über die Häufigkeit von Drogenfahrten und deren Charakteristiken vorgestellt. Um die Daten über Konsum und Fahren so zeitnah wie möglich erheben zu können, wurde als Methodik zur täglichen Selbstaufzeichnung von Verhalten eine Art Tagebuchverfahren gewählt, indem Smartphones zur Datensammlung eingesetzt wurden (Datenübertragung über GPRS). Insgesamt wurden 195 Drogenkonsumenten (hauptsächlich Cannabiskonsumenten)[1] und 100 Kontrollpersonen (keine illegalen Drogen, Alkohol erlaubt) aus der allgemeinen Fahrerpopulation untersucht. Die Daten, die über den standardisierten, aber adaptiven täglichen Fragebogen erhoben wurden, beziehen sich auf alle täglichen Aktivitäten und Wege, mit besonderem Schwerpunkt auf Drogenkonsum[2] und Fahren. Die erhobenen Konsum- und Fahrdaten erwiesen sich als vergleichbar mit den repräsentativen Drogenprävalenzen und Mobilitätsdaten bezogen auf die deutsche Allgemeinbevölkerung (ESA 2006, MiD 2008). Über die Verknüpfung der beiden Datenbestände war es möglich, für jede Fahrt Substanzkonzentrationen im Blut zu berechnen und somit Aussagen über das Vorkommen von Drogenfahrten zu treffen. Überdies wurde umfangreiches Datenmaterial zu personenbezogenen Merkmalen (z.B. soziodemographische Informationen, relevante Vorerfahrungen, Persönlichkeitsmerkmale, Einstellungen, usw.) erhoben. So konnten individuelle Faktoren, die das Auftreten von Drogenfahrten begünstigen, identifiziert werden.

Prävalenz von Fahrten unter dem Einfluss psychoaktiver Substanzen bezogen auf die deutsche Allgemeinbevölkerung

Im Mittel waren 20.5% der Fahrten der untersuchten Konsumenten Drogenfahrten. Die häufigste Substanz, unter deren Einfluss gefahren wurde, war Cannabis. Für

[1] Ursprünglich 200 Drogenkonsumenten; 5 wurden aus der Datenanalyse ausgeschlossen, weil sie während der Datenerhebung kein Cannabis konsumiert hatten.
[2] Konsum von illegalen Drogen, Alkohol, Missbrauch psychoaktiver verschreibungspflichtiger Medikamente.

durchschnittlich 13.1% der Fahrten wurde eine positive THC[3]-Blutplasmakonzentration berechnet (insgesamt, d.h. inklusive Drogenkombinationen: 14.8%). Durchschnittlich 4.1% der Fahrten fanden unter dem Einfluss von Alkohol (insgesamt: 5.4%) und 1.5% unter dem Einfluss von Stimulantien[4] (insgesamt: 2.2%) statt. Der durchschnittliche Prozentsatz von Fahrten unter dem Einfluss mehrerer Drogen[5] liegt bei 1.8%. Die häufigste Substanzkombination, die auftrat, war Alkohol und Cannabis (1%). Die Cut-off-Werte, die verwendet wurden, um eine Fahrt als Drogenfahrt zu klassifizieren (Blutalkoholkonzentration, BAK≥0.01%, THC-Blutplasmakonzentration≥1ng/ml), waren relativ niedrig. Verwendet man höhere Cut-off-Werte, wie z.B. eine BAK von 0.05% oder eine THC-Blutplasmakonzentration von 4ng/ml[6], verringert sich der mittlere Prozentsatz von Substanzfahrten um ca. 40% von vorher 20.5% auf 13.1%.

Über repräsentative deutsche Mobilitäts- und Drogenprävalenzdaten (MID 2008, ESA 2006) wurden die Studienergebnisse zu Alkohol-, THC- und Stimulantien-Prävalenzen für die allgemeine deutsche Fahrerpopulation hochgerechnet. Gemäß dieser Berechnung liegt die Prävalenz für THC-Fahrten (THC-Blutplasmakonzentration≥1ng/ml) in Deutschland bei 0.14% (95% CI: 0.09% - 0.2%). Für Fahrten unter dem Einfluss von Stimulantien (Kokain ein- oder ausgeschlossen) liegt die Prävalenz bei 0.02% (95% CI: 0.01% - 0.04%), für Fahrten unter dem Einfluss mehrerer Drogen (jegliche Drogenkombination, Alkohol inklusive) bei 0.02% (95% CI: 0.01% - 0.03%). Fahrten unter dem Einfluss von Alkohol in Kombination mit illegalen Drogen kommen zu 0.01% (95% CI: 0.006% - 0.02%) vor. Innerhalb der 18-24-jährigen deutschen Fahrerpopulation liegt die Prävalenz von Alkoholfahrten (BAK≥0.01%) bei 1.57% (95% CI: 0.52% - 2.7%), innerhalb der 25-39-jährigen Fahrerpopulation bei 3.3% (95% CI: 1.63% - 5%).

Situative Aspekte von Drogenkonsum und Drogenfahrten

Die in den Ergebnissen gefundenen Unterschiede zwischen Konsumenten und Kontrollpersonen weisen darauf hin, dass Drogenkonsum gewisse Auswirkungen auf die Gestaltung des Alltags einer Person hat. Insgesamt scheinen Kontrollpersonen im Vergleich zu Drogenkonsumenten eher einem geregelten Arbeitsalltag nachzugehen.

Das Ausmaß des individuellen Drogenkonsums variiert in Abhängigkeit von Tageszeit, Wochentag und Art der Substanz. Natürlich wirken sich diese Abhängigkeiten ebenso auf das Auftreten von Drogenfahrten aus. Weitere situative Einflussfaktoren für Drogenfahrten sind die Länge der zurückzulegenden Strecke, die Verfügbarkeit alternativer Fortbewegungsmittel sowie weibliche Begleitpersonen.

[3] Delta-9-tetrahydrocannabinol.
[4] Amphetamine, Ecstasy, Kokain.
[5] Cannabis/Alcohol, Cannabis/Stimulantien, Alcohol/Stimulantien, Cannabis/Heroin, Cannabis/Alcohol/Stimulantien.
[6] Gemäß Berghaus, Sticht und Grellner (2011) entspricht eine THC-Blutplasmakonzentration von 3.8ng/ml in Bezug auf leistungsbeeinträchtigende Effekte der Substanz einer BAK von 0.05%.

Personenbezogene Aspekte von Drogenkonsum und Drogenfahrten

Doch welche Personen tragen vorwiegend zum Vorkommen von Drogenfahrten bei? Fährt jeder, der Drogen konsumiert, auch unter Drogeneinfluss Auto? Wenn lediglich die Fahrten innerhalb der Stichprobe als Fahrten mit hohem Risikopotential angesehen werden, bei denen ein THC-Blutplasmawert von 4ng/ml oder mehr und/oder eine Blutalkoholkonzentration über dem Grenzwert berechnet wurde, so waren lediglich 20% der Konsumenten verantwortlich für 80% dieser Fahrten. 19% der Konsumenten hätten nach dieser Definition überhaupt keine Fahrt mit hohem Risikopotential begangen.

Als wesentlicher Prädiktor für häufige Drogenfahrten und hohe Substanzkonzentrationen im Blut während der Fahrt kann ein hoher Konsum genannt werden. Damit verbunden sind riskante Konsummuster sowie eine geringe subjektive Beeinträchtigung nach dem Konsum von Drogen.

Des Weiteren ergab die Analyse der objektiven Beeinträchtigung durch die Wirkung von Drogen mittels der computerbasierten Act & React Testsystem (ART) 2020 Standard Testbatterie, die vom Kuratorium für Verkehrssicherheit (KVF; englisch: ARSB – Austrian Road Safety Board) entwickelt wurde[7], nur geringe Effekte. Es zeigte sich, dass der akute Einfluss von Cannabis die psychometrische Leistung nur teilweise beeinträchtigt und dass negative Langzeitfolgen bei starkem (lifetime) Drogenkonsum zwar zum Teil nachgewiesen werden konnten, leichter (lifetime) Drogenkonsum die Leistung jedoch so gut wie gar nicht beeinträchtigt.

Die vorliegende Studie konnte auch demonstrieren, dass es keine Hinweise dafür gibt, dass Drogenfahrer, außer durch die Drogenfahrten an sich, auch sonst im Verkehr auffällig werden. Dieser Befund beruht auf (1) Eintragungen im Verkehrszentralregister des Kraftfahrt-Bundesamtes und auf (2) Berichten über gefährliche Verkehrssituationen, die während der Erhebung aufgetreten sind.

Gemäß der Befunde eines Literaturreviews, das vor der Studie durchgeführt wurde, wurden Fragebögen eingesetzt, die Persönlichkeitsdimensionen erfassen, die in Zusammenhang mit Drogenkonsum und Drogenfahrten von Relevanz sein dürften. Es stellte sich heraus, dass Drogenkonsum mit einigen wesentlichen Persönlichkeitsmerkmalen assoziiert ist (z.B. Sesation-seeking, Hyperaktiviät/ Impulsivität, geringe Selbstkontrolle, unkonventionelles Verhalten) und dass Drogen häufig missbräuchlich eingenommen werden, um persönliche Probleme zu lösen (z.B. psychologische und soziale Probleme aufgrund von Hyperaktiviät/Impulsiviät, Stress). Weniger deutlich, aber ähnlich gerichtet, zeigen sich auch Unterschiede zwischen Konsumenten, die häufig unter Drogen Auto fahren, und solchen, die dies nicht tun.

[7] Sieben Untertest der Testbatterie wurden durchgeführt; sie messen folgende Leistungsdimensionen: Orientierung (LL5, PVT, SENSO), Konzentration und Aufmerksamkeit (Q1), Reaktionfähigkeit (RST3), Belastbarkeit (RST3), Merkfähigkeit (GEMAT3) und Intelligenz (MAT).

Die Erfassung möglicher psychischer Störungsbilder durch das Strukturierte Klinische Interview für DSM-IV Achse I Störungen (SKID-I; Wittchen, Zaudig, & Fydrich, 1997) zeigte, dass Konsumenten etwas häufiger psychische Probleme aufweisen als Kontrollen (hauptsächlich durch ein häufigeres Vorkommen von Major Depression mit rezidivierenden Episoden, Bipolaren Störungen, AD(H)D und Borderline Persönlichkeitsstörung). Bei den Konsumenten wurde überdies ausgeprochen häufig (lifetime) Drogenabhängigkeit und -missbrauch diagnostiziert (Missbrauch: 33.8%, Abhängigkeit: 61%).

Die Ergebnisse der Studie stimmen außerdem mit Hypothesen überein, die aus der Sozialen Lerntheorie und der Sozialen Kontrolltheorie (Bahr, Hoffmann & Yang, 2005; Hirschi, 1969, zitiert in Bahr et al., 2005) bekannt sind. Diese Theorien betonen den Einfluss von Eltern und Freunden als Rollenvorbilder auf die Entwicklung von Problemverhalten sowie den positiven Einfluss einer guten Eltern-Kind-Beziehung auf die Entwicklung konventioneller Werte und auf die Ablehnung von deviantem Verhalten seitens des Kindes.

Basierend auf Ajzen's (1985) Theorie des geplanten Verhaltens, die aus der Theorie des überlegten Handelns (Fishbein & Ajzen, 1980) entwickelt wurde, sollten Präventionsmaßnahmen auf Einstellungsänderungen fokussiert sein, da Einstellungen Verhalten beeinflussen. Durch die vorliegende Studie konnte gezeigt werden, dass die Einstellung der Versuchspersonen zu Drogenfahrten sowie ihre Annahmen über soziale Normen zum großen Teil mit ihrem Verhalten übereinstimmen. Drogenkonsumenten haben eher liberale Einstellungen zu Drogenkonsum und Drogenfahrten.

Es gibt zahlreiche Befunde, die belegen, dass Sanktionen und polizeiliche Überwachung durch das Wirkprinzip der Abschreckung das Unterlassen sicherheitswidrigen Verkehrsverhaltens bewirken können (z.B. Paternoster, Saltzman, Chiricos, & Waldo, 1982, zitiert in Albery & Guppy, 1995). Durch die Ergebnisse der Studie konnte der Abschreckungseffekt dieser Maßnahmen und seine Abhängigkeit von der Akzeptanz und der subjektiven Wahrnehmung der Maßnahmen aufgezeigt werden.

Erkenntnisse für Prävention und Rehabilitation

Die Ergebnisse der vorliegenden Arbeit wurden in ein Model von Hargutt (zitiert in Krisman & Schöch, 2011: Draft of a model-tool, Section 9.2) integriert, das Abhängigkeiten zwischen gesellschaftlichen Variablen, Verhaltensparametern und gesetzlichen Gegebenheiten aufzeigt, die in Zusammenhang mit dem Auftreten von Drogenfahrten von gewisser Relevanz sind. Daraus wurden Empfehlungen für die Entwicklung von Präventions- und Rehabilitationsmaßnahmen in Übereinstimmung mit wissenschaftlichen Befunden aus anderen Forschungsarbeiten abgeleitet.

Methodische Gesichtspunkte

Bei der Durchführung der Studie waren zwei Herausforderungen zu bewältigen – zum einen die Rekrutierung von Drogenkonsumenten, zum anderen die Implementierung des neuen methodischen Ansatzes.

Eine Zufallsstichprobe konnte aufgrund des Studiendesigns nicht umgesetzt werden. So waren Bemühungen, die Studie durch Öffentlichkeitsarbeit für die Bevölkerung zugänglich zu machen, von großer Bedeutung. Hierfür wurde eine breit angelegte Rekrutierungsstrategie entwickelt. Der Vergleich der Stichprobe mit konfundierenden Populationsparametern zeigte, dass die Stichprobe die Allgemeinbevölkerung zufriedenstellend widerspiegelt.

Die neue Methode wurde in einem iterativen Prozess entwickelt. Die Entwicklungsarbeit umfasste das konzeptionelle Design des komplexen Smartphone-Fragebogens, die Planung und Organisation des Studienablaufs sowie die umfangreiche und unmittelbare Kontrolle der eingegangen Daten.

Abschließende Bemerkung

Die vorliegende Arbeit ermöglichte es, eine Datenbasis zu generieren, mit der nicht nur die Prävalenz von Drogenfahren quantifiziert werden konnte, sondern auch relevante Mediator- und Moderatorvariablen untersucht werden können. Im Hinblick auf Prävention und Rehabilitation können so wertvolle Informationen gewonnen werden. Die neue Methode der Datenaquirierung erwies sich als vielversprechend und sollte als Standard in künftigen Studien weiterentwickelt werden.

EXECUTIVE SUMMARY

The aim of the present piece of work was to give information about the frequency of psychoactive substances within the German driver population and to identify preventive and promotive circumstances of drug driving. The results of the present study serve as major input to the discussion on drug driving and can be of practical use for rehabilitation and prevention purposes.

In Germany, representative data about drug use (Epidemiological survey on substance abuse among adults in Germany – ESA 2006; Kraus, Pfeiffer-Gerschel & Pabst, 2008) and driving behaviour (Mobility in Germany – MID 2008; http://www.mobilitaet-in-deutschland.de) are available every few years. Nevertheless, what has been lacking up to now is the combination of both data in order to get detailed information about driving under the influence of psychoactive substances (DUI) in Germany.

To close this gap of information, the present study introduces a new methodological approach to gather information about the frequency and circumstances of drug driving. To capture real-time data about drug consumption and driving, a repeated-entry diary technique was applied by using smartphones as study devices (data transmission via GPRS). In total, 195 drug users (mainly cannabis users)[8] and 100 controls (no use of illicit drugs, alcohol consumption allowed) out of the normal driving population were sampled. The data that were gathered by the standardised, but adaptive daily questionnaire refer to all daily activities and trips, with a special focus on drug consumption[9] and driving. The reported consumption and driving data were found to be comparable to existing drug prevalence and mobility data of the general German population (ESA 2006; MID 2008). The synchronisation of these data about drug consumption and driving incidences made it possible to calculate substance concentrations in blood for every drive and, thus, to determine the occurrence of drug driving. Furthermore, an extended diagnostic part was included in the study to gather person-related characteristics (e.g. sociodemographic information, relevant previous experiences, personality variables, attitudes, etc.). So, individual factors that are associated with drug driving can be specified.

Prevalence of psychoactive substances within the German driver population

Averaged per person, 20.5% of the users' drives were under the influence of drugs. The most prevalent drug that was found while driving was cannabis. The mean percentage of drives under the influence of cannabis alone was 13.1% (total, i.e. drug combinations included: 14.8%). On average, 4.1% of the users' drives were under the influence of alcohol (total: 5.4%) and 1.5% under the influence of stimulants[10] (total: 2.2%). The mean percentage of drives under the influence of

[8] Originally 200 users, 5 were excluded from all analyses because they did not use cannabis within the study period.
[9] Use of illegal drugs, alcohol, abuse of psychoactive prescription medicines.
[10] Amphetamine, ecstasy, cocaine.

multiple drugs[11] was 1.8%. The most frequently found drug combination was alcohol and cannabis (1%). The cut-off values for defining a drive as drive under influence are rather low (BAC[12]≥0.01%; THC[13] blood plasma level≥ 1ng/ml). When applying higher cut-off values, like a BAC of 0.05% and a THC blood plasma level of 4ng/ml[14], the mean percentage of drives under influence within the user sample drops by around 40% from a previous 20.5% to 13.1%.

Via existing mobility measures and prevalence data for drug use in Germany (ESA 2006, MID 2008), the survey results were extrapolated into alcohol, THC and stimulants prevalences for the general German driving population. According to this estimation, the prevalence of THC-positive drives (THC blood plasma level≥1ng/ml) in Germany is 0.14% (95% CI: 0.09% - 0.2%). For drives under the influence of stimulants (cocaine in- or excluded), the prevalence is 0.02% (95% CI: 0.01% - 0.04%). For drives under the influence of multiple drugs (any drug combination, alcohol included), the prevalence is 0.02% (95% CI: 0.01% - 0.03%). For drives under the influence of alcohol in combination with an illegal drug, the prevalence is 0.01% (95% CI: 0.006% - 0.02%). For the 18-24-year-old German population, the prevalence for alcohol-positive drives (BAC≥0.01%) is 1.57% (95% CI: 0.52% - 2.7%) and 3.3% (95% CI: 1.63% - 5%) for 25-39-year-olds.

Situational aspects associated with drug use and drug driving

The results show differences between users and controls on several variables. The differences indicate that substance use impacts on the structuring of day-to-day life. Overall, the controls' days proceed more along a daily working routine than the users'.

The individual extent to which drugs are consumed differs dependent on daytime, day of the week and kind of substance. Of course, these dependencies also influence the occurrence of drug driving. Other factors of influence on drug driving are the distance, the availability of alternative modes of transport as well as the presence of female companions.

Person-related factors of drug use and drug driving

But who then is contributing to the occurrence of DUI? Does every drug user commit drives under influence or is it a special sub-group? If only drives with a positive THC blood plasma level of 4ng/ml and higher and/or drives with a positive BAC above the legal limit are considered as drives with a high risk potential, only 20% of all users were responsible for 80% of these drives. After this definition, 19% of all users would have had no drive with a high risk potential at all.

[11] Cannabis/alcohol, cannabis/stimulants, alcohol/stimulants, cannabis/heroin, cannabis/alcohol/stimulants.
[12] Blood alcohol concentration.
[13] Delta-9-tetrahydrocannabinol.
[14] According to Berghaus, Sticht and Grellner (2011) a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.

A striking predictor for frequent drug driving and highly intoxicated driving in general is a high consumption frequency, associated with risky consumption patterns and a low subjective feeling of impairment after drug consumption.

Besides, only small effects were found when examining the objective impairment caused by drug use with the computer-based Act & React Test System (ART) 2020 Standard test battery, developed by the Austrian Road Safety Board (ARSB)[15]. It was found that acute cannabis intoxication only partly affects the psychometric performance and that negative long-term performance effects of heavy lifetime drug use exist to some extent while light lifetime drug use has no negative impact.

The present study could also demonstrate that, except from driving under influence, there is no evidence to suggest that DUI offenders also show problematic behaviour according to other traffic-related measures. This finding is based on (1) the records that are stored in the German Central Register of Traffic Offenders and on (2) self-reported dangerous traffic situations within the study period.

According to evidence from a literature review that was conducted prior to the study, questionnaires that assess personality dimensions with a supposed relevance in the context of drug use and drug driving were applied. It turned out that drug use seems to be associated with some crucial personality dimensions (e.g. sensation seeking, hyperactivity/impulsivity, less self-control, rather unconventional behaviour, etc.) and drugs seem to be misused to solve personal problems (e.g. psychological and social problems due to hyperactivity/impulsivity, feelings of distress). A less precise but similar difference was found for users who commit many drives under influence compared to users who never or only sometimes drive under influence.

The assessment of mental disorders by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; Wittchen, Zaudig, & Fydrich, 1997) showed that users marginally more often have psychological problems compared to controls (particularly due to a higher frequency of Major Depression with Recurrent Episodes, Bipolar Disorders, AD(H)D and Borderline Personality Disorder). Lifetime Drug Abuse or Drug Dependence was quite often found within the user sample (Drug Abuse: 33.8%, Drug Dependence: 61%).

The results also go in line with hypothesis that were drawn from Social Learning and Social Control Theory (Bahr, Hoffmann, & Yang, 2005; Hirschi, 1969, cited in Bahr et al., 2005), which stress the influence of parents and peers as role models on the development of problematic behaviour and the positive impact of a good relationship between parents and children on the development of conventional values and on the rejection of deviant behaviour on behalf of the child.

Based on Ajzen's (1985) theory of planned behaviour, which was developed from the theory of reasoned action (Fishbein & Ajzen, 1980), prevention measures should

[15] Seven sub-tests of the test battery were applied, which measure the following performance dimensions: coordination capacity (LL5, PVT, SENSO), concentration and attention capacity (Q1), reaction capacity (RST3), stress resistance (RST3), memory capacity (GEMAT3), and intelligence (MAT).

focus on attitudinal changes because attitudes influence behaviour. By the present study, it was found that the subjects' attitudes towards drug driving and their beliefs about social norms largely go in line with the behaviour they engage in. Drug users have rather liberal attitudes towards drug use and driving under influence.

There are numerous findings that support the effectiveness of sanctioning and police enforcement by deterring from high risk road user behaviour (e.g. Paternoster, Saltzman, Chiricos, & Waldo, 1982, cited in Albery & Guppy, 1995). By the results of the present study, the deterrence effect of such measures and its dependence on the acceptance and awareness of the measures could be shown.

Insights for prevention and rehabilitation

The results of the present piece of work were integrated in a model by Hargutt (cited in Krisman & Schöch, 2011: Draft of a model-tool, Section 9.2) that shows dependencies of different societal, behavioural and legal variables that are relevant in the context of developing measures to combat driving under influence. Insights for rehabilitation and prevention were drawn in accordance with scientific findings of other research activities.

Main methodological issues

When conducting the study, two challenges were faced – the recruitment of drug using subjects and the implementation of the new method.

Random sampling was not viable. So, much effort had to be spent on media relations to publicise a transparent picture of the study. For this purpose, a broad recruitment strategy was developed. The comparison of the sample with confounding population parameters showed that it reflects the general population quite satisfactory.

The new method was developed in an iterative process. The developmental work consisted of the conceptual design of the complex smartphone questionnaire, the planning and organising of the study schedule and the comprehensive and immediate control of the received data.

Final remarks

Through the present study, it was possible to create a database for not only quantifying the prevalence of driving under influence but also for analysing mediating and moderating factors. With respect to rehabilitation and prevention, valueable information can be gained. The new methodological approach of data collection has proved to be a promising method and should serve as a standard to which future studies should aspire.

THEORETICAL PART

1. Introduction

In Germany, alcohol accidents that have been registered by the police from 2000 to 2009 decreased by around 20% from 7.1% of all accidents that involved personal injury to 5.6%. Even if accidents that were registered as accidents under the influence of other drugs than alcohol only amount to 0.42% of all accidents that involved personal injury in 2009, an increase of around 60% compared to 2000 (0.27%) can be reported (Destatis, 2011a).

These statistics have limitations concerning validity because they are dependent on several factors, e.g. the accident classification system that is used, the existing law and the initiation and effectiveness of police operations. It does not get clear from these values how high the accident risk for driving under the influence of drugs is because nothing is known about the prevalence of drug driving in the general population. If e.g. the proportion of driving under the influence of illicit drugs in general would be as high as the proportion of driving under the influence of alcohol, the above mentioned accident numbers would indicate that the latter is much more dangerous. Furthermore, such official statistics do not reveal influencing factors that are responsible for a demonstrated development over time (e.g. changes in drug consumption, attitudinal changes, better knowledge about risks). Such insights, however, could be useful for identifying persons most at risk and for developing effective countermeasures.

The aim of the DRUID project (Driving under the influence of drugs, alcohol and medicines), which was launched from 2006 to 2011, was to gain new insights to the real degree of impairment caused by psychoactive substances, their actual impact on road safety as well as the potential of different countermeasures to combat driving under influence. To fulfil this aim, scientifically well-demonstrated knowledge, experience and methods were applied. The main objective of Work Package 2 of the DRUID project was to determine the prevalence and accident risk of alcohol and other psychoactive substances in the general driving population in Europe. There are numerous methodological approaches for estimating the relative risk (e.g. case-control-studies, culpability studies), whereas there is only one reliable approach for estimating prevalence rates so far, i.e. conducting a roadside survey. Nevertheless, only few roadside surveys have been carried out in Europe so far (e.g. Krüger, Schulz, & Magerl, 1996). One reason for this is the time and organisational effort as a large sample size is necessary, especially when looking for substances with a low prevalence in traffic. Another reason is legal restrictions that often impede the realisation of roadside surveys.

There are various study approaches to be found in the literature that gather information about situational characteristics and person-related factors of driving

under influence, primarily conducted as interviews. The aim of these studys is to cast light on the phenomenon of drug driving by providing information about preventive and promotive circumstances. Such information is useful with respect to recommendations concerning prevention and rehabilitation. Nevetheless, most studies only refer to single aspects of the whole phenomenon, without bringing the results in a broader context, which itself could reveal new, previously ignored interactions.

The main prerequisite for being at risk of driving under the influence of drugs is that a person is participating in traffic as driver of a motor vehicle and is using drugs in general. To estimate the prevalence of drug consumption in general, representative data documented by national and international institutions every few years can be used. In Germany, the data of the Epidemiological survey on substance abuse among adults in Germany (ESA; e.g. Kraus, Pfeiffer-Gerschel, & Pabst, 2008) are available. There are also representative data about driving behaviour from the survey Mobility in Germany (“Mobilität in Deutschland” – MID; for more information see http://www.mobilitaet-in-deutschland.de). Nevertheless, what has been lacking up to now is the combination of both data.

2. Objectives

The basic intention of the present study was to introduce a new methodological approach to gather information about the prevalence and associated situational and person-related circumstances of drug driving.

The novelty of the approach was fourfold:

1) Instead of detecting drugs in the driving population, as roadside surveys do, drug using subjects who regularly drive a motor vehicle were queried about all daily activities – with a special focus on drug use and driving. By matching the data about drug consumption and driving incidences, it was possible to determine the occurrence of drug driving.
2) The questionnaire had to be filled in each day for 28 consecutive days. On the one hand, by longitudinal data behavioural patterns can be identified. On the other hand, a prolonged study period enables the application of additional questionnaires and interviews to gather further relevant background information. So, inter-individual and intra-individual variance can be studied in detail.
3) As all daily activities had to be recorded in the daily questionnaire, surrounding conditions of drug driving as well as of situations in which drug driving did not occur could be specified.
4) The applied daily questionnaire was electronically presented on smartphones. Portable recording devices allow the subjects to report behaviour promptly after it has been occurred. Therefore, biases resulting from retrospective reporting can be minimised and the overall quality of data maximised.

It was aimed at investigating 200 drug users (mainly cannabis users) and 100 controls (no use of illicit drugs; alcohol consumption allowed). Because the applied study design did not allow for random sampling, much effort had to be spent to publicise the study by a broad recruitment strategy. It was tried to sample the whole population at risk of driving under influence (18-39-year-olds, regular drivers), stratified according to driving- and drug use-relevant variables (gender, age, residence).

To make assumptions about how representative the reported drug use and driving data were, indeed, these data were compared to representative data (ESA 2006, MiD 2008). The representative data also served as a database from where weights were deduced from to extrapolate the number of drug driving incidences found within the sample into representative figures.

By the extended diagnostic part that was included in the study, relevant sociodemographic information, relevant previous experiences, personality variables, psychiatric conditions, social context information as well as attitudes and perceptions were assessed. Thereby, the characteristics of drug driving individuals could be specified in order to give recommendations for rehabilitation and prevention.

Self-reported data about individual drug use gain a higher validity if the reported consumption is controlled by objective measures, wherefore urine samples were collected once within the study period. Additionally, the traffic-specific performance of the users was tested with the computer-based Act & React Test System (ART) 2020 Standard test battery and compared to that of the controls to make assumptions about the real degree of impairment caused by drug use. The subjects' records saved at the Central Register of Traffic Offenders were requested to get objective information about former traffic conspicuousness.

The study was part of Work Package 2 within the DRUID project and has already been published by the author of the present dissertation as DRUID Deliverable 2.2.2 Part I and Part II (Walter, Hargutt & Krüger, 2011a; Walter, Hargutt & Krüger, 2011b). For reasons of clarity, the two parts of Deliverable 2.2.2 are not further referenced.

3. Epidemiological research

3.1 Methods of epidemiological research

In general, there are two methodological approaches in epidemiological research (Berghaus & Krüger, 2007; Krüger & Vollrath, 2009):

1) descriptive methods, which describe the prevalence of the behaviour in question within a population, and
2) analytical methods, which estimate the risk that the behaviour contributes to.

3.1.1 Descriptive methods of epidemiological research

Of the descriptive methods of epidemiological research (Berghaus & Krüger, 2007; Krüger & Vollrath, 2009), roadside surveys are the most preferable study type. By this study type, the prevalence of substances in traffic is directly measured in a random sample. The validity of the data depends on the methodological quality.

Huge expenses are necessary to conduct a roadside survey. The common study design involves to sample drivers from the general traffic at randomly selected locations. Therefore, representative regions have to be chosen within the area that is under investigation. The study population sample has to be stratified into different time periods over the week, which cover all days of the week and all times of the day. Usually, drivers need to be stopped and are breath tested for alcohol by the police. Afterwards, the research team is able to conduct an interview with the drivers and take a blood or saliva sample. Special facilities are needed to collect the body fluids under the given legal requirements. The stopped drivers are asked to cooperate on a voluntary basis. In some countries, informed consent is mandatory. Since random sampling is applied in roadside surveys, drivers are expected to be representative for gender and age. However, the selection of the samples usually can not be entirely distributed equally with traffic volumes over the different time periods. In order to correct for differences, weight factors have to be calculated from data about the general distribution of traffic, derived from national traffic surveys. The body fluids are toxicological analysed for predefined core substances. For many substances, the concentrations in oral fluid are much higher than in blood, while for other compounds the concentrations are lower (Gjerde, Mordal, Christophersen, Bramness, & Mørland, 2010, Wille et al., 2009, cited in Houwing et al., 2011a). To be able to quantify the prevalence of drug-positive drives on the basis of the presence of drugs in blood, cut-offs have to be used for substance concentrations in oral fluid that are the equivalent of the analytical cut-off in blood (equivalent cut-off).

Likewise, statistics about the detection of DUI in police controls give information about the prevalence of substances in traffic. But in many Euopean countries, as in Germany, the police require some form of suspicion before drivers can be stopped

for tests (see http://www.emcdda.europa.eu/html.cfm/index19034EN.html). So, drivers who have low drug tolerance might get detected more often than drivers whose reaction to a drug is progressively reduced. The probability of getting detected also depends on how good police officers are trained to identify impairment. Police controls are also not random with respect to time, day and region. They take place more often when drug driving is supposed to be most prevalent (e.g. at night, on weekends). Above all, the time delay between the police stop and blood sampling results in inaccurate relations between substance blood concentrations and impairment (Hargutt, Krüger, & Knoche, 2011). In Germany, driving under the influence of illegal substances is an offence since 1998. Nevertheless, suspected drivers get exclusively tested for alcohol by a breath test in most of the cases. In general, only a breath test content above the legal limit leads to blood sampling and even in the case of a positive breath test the toxicological analysis is in most of the cases constricted to alcohol.

Of course, blood samples taken from drunken drivers can be re-analysed for other substances. Anyhow, the results can exclusively be used to address the issue of concomitant substance use within the specific sample of drunken drivers who were stopped by the police because they were suspected to be impaired. Because of the above mentioned limitations of samples of suspected drivers, the data gives neither information about the prevalence of drug use in alcohol users nor the prevalence of drugs in drunken drivers.

Another source of information can be drawn from accident victims who are hospitalised or from killed persons who are taken to an Institute of Legal Medicine. In both cases and independent from suspicion, body fluids are taken from the involved traffic participants and are toxicologically screened. In Germany, it is mandatory to obtain consent from the victim or the relatives of the killed person in order to do a screening. It is obvious that victims who were driving under the influence of a substance will refuse to submit to a drug screening. Furthermore, the results of such analyses do not refer to all traffic situations but are constricted to accidents, namely accidents that contain personal injury. Besides, regional differences can have an influence on how often an accident occurs, e.g. the occurrence of motorways, traffic calmed areas, etc.. At dangerous traffic sites, the proportion of drug driving in a sample of accident victims is supposedly lower. Last but not least, the time difference between the extraction and analysis of the body fluid and the accident is rather big because the medical treatment has top priority.

Data about substances in accidents can also be gathered in cooperation with the police. In this case, the police are asked to collect body fluids and further relevant information, no matter whether the driver is under suspicion of driving under influence. But the data still have limitations, because the police is not called to every accident.

Indirect sources of information are official statistics about traffic accidents that are available in most countries. These data are biased because of several reasons. The applied categorisation system is usually limited. E.g., an accident is categorised as an alcohol accident if an involved person is under the influence of alcohol, no matter whether the drunken person was the causal agent of the accident. There are also

differences concerning the classification of accidents between different European countries. E.g., the definition of accidents that involve killed persons is variing depending on how long after an accident the person died. Besides, legal amendments can restrict the comparability of the data. E.g., it was not until 1998 that a law was introduced in Germany that made driving under the influence of illegal substances an offence in the first place. Since then, the screening of illegal drugs in traffic has become more prevalent. So, within German official statistics the prevalence of drug driving markedly increased from then on.

Information about the occurrence of DUI can also be indirectly drawn from existing representative data about drug use and driving documented by national and international institutions (in Germany: ESA, MiD). To know how often a special population uses drugs and how often this population drives a car, can provide information about how likely it is that drug driving occurs within this population.

Interviews are surely the method with the most diverse possiblities to gather information about the frequency and the circumstances of drug driving. By interviews, it is possible to focus different driver groups, e.g. drivers of different ages or drivers with different consumption patterns. Specific questions can be asked concerning associated variables, like attitudes, the social background or the personality of drug drivers. In-dephts information can be gathered to not only shed light on the actual behaviour but also on motives behind it. In order to be able to gather valuable data, an important issue that needs to be accounted for is the careful selection of the sample. The more representative the subjects are with respect to defined classification criteria, the higher value the results of a survey have. Anyhow, the basic problem of interviews is that subjects give either global self-ratings or make retrospective statements that are both prone to intentionally or unintentionally biases (Reuschenbach & Funke, 2011; Hufford, Shiffman, Paty, & Stone, 2001; Fahrenberg, Myrtek, Pawlik, & Perrez, 2007; Turkkan, 2000; Jobe, 2000; Baldwin, 2000). Therefore, the questions that are asked should be clearly phrased in order to get reliable data. If possible, the questions should be derived from empirical findings and also be supported by objective information to highten the validity of the results. Of course, qualitative indepth-interviews with a small group of subjects can help to form hypotheses. But to deduce general assumptions by a survey result, the sample size has to be sufficiently large.

3.1.2 Analytical methods of epidemiological research

The purpose of analytical methods of epidemiological research (Berghaus & Krüger, 2007; Krüger & Vollrath, 2009) is the estimation of the traffic risk that a certain behaviour in traffic contributes to. The prevalence that describes the frequency of a harmful traffic occasion is the absolute risk, i.e. the probability that the harmful traffic event itself occurs. Analytical methods try to find out to what extent the presence of a certain factor alters the probability that the harmful traffic event occurs, so to say if the factor has a promotive or preventive effect on traffic safety. To evaluate the detrimental effects of risk factors on traffic safety, two measures can be used:

1) *Relative Risk*:
   Risk of harmful event if risk factor is present / Risk of harmful event if risk factor is absent (Table 1)
   The Relative Risk indicates the factor by which the risk of the harmful event is multiplied if the risk factor is present.
2) *Odds Ratio*:
   Chance for harmful event if risk factor is present / Chance for harmful event if risk factor is absent (Table 1)
   It can reach values from zero to infinity. The Odds Ratio is the most frequently used measure to estimate accident risk. It can be used independently of the study method that is applied. An Odds Ratio above 1 indicates that the chance to have an accident is increased if the risk factor is present.

Table 1: Definition of the terms Risk and Chance (for the calculation of Relative Risks and Odds Ratios).

		Risk factor		
		present	not present	
Harmful event	present	a	b	a+b
	not present	c	d	c+d
		a+c	b+d	a+b+c+d
Risk:	Risk of harmful event if risk factor is present: $\frac{a}{a+c}$		Risk of harmful event if risk factor is absent: $\frac{b}{b+d}$	
Chance:	Chance of harmful event if risk factor is present: $\frac{a}{c}$		Chance of harmful event if risk factor is absent: $\frac{b}{d}$	

In epidemiological research, the distribution of the subjects to the study groups can not be controlled by the researcher. But, it is important to make sure that the groups are comparable on relevant variables, i.e. on those that are thought to be confounded with the behaviour under investigation and the underlying behaviours, respectively.

So-called case-control studies are the method of choice to calculate accident risks. In case-control studies, accident risks are calculated from data that comprise accidents and comparable accident-free controls. The data can consist of representative data about the frequency of accident-free drives and the occurrence of accidents within a defined region, separated according to the presence or absence of the risk factor that is investigated. Besides, accident-free control data can be systematically collected according to the composition of a respresentative accident sample with regards to its inherent characteristics (e.g. time, day, place of accident).

Culpability studies are another, although a less optimal approach to assess the accident risk that emanates from a risk factor. In culpability studies, there does not exist an accident-free control group to which the accident group is compared to. Here, the two drivers that are involved in an accident are classified as culpable and not culpable driver, repectively. The drivers that were classified as not culpable serve as controls to which culpable drivers are compared to. With respect to the comparability of the surrounding factors of the traffic scene, the not culpable drivers match perfectly the sample of culpable drivers. But, the sample solely exists of subjects that were involved in an accident. The sample is a sub-population of the general driver popula-

tion, which limits the generalisability of the results. Besides, the decision about the culpability of a driver is often not easy to take. Beyond that, it is sometimes questionable if the inculpable driver could not have prevented the accident by a more anticipatory driving style. Last but not least, single-vehicle accidents can not be included in the analyses but especially are relevant when it comes to accidents that were caused by a driver while being under the influence of drugs.

Because in the case of medicines, many different substances are on the market and each one is used by a relatively small number of patients, an approach called pharmacoepidemiology has been established. In pharmacoepidemiological studys, person-related data about pharmaceutical prescriptions, which are received from physicians, get combined with information about the patient's conspicuous behaviour in traffic, which is recorded in national data bases. By this method, it is possible to easily access the data of many people. Thus, it can be determined whether drivers who are exposed to psychoactive medicines commit more traffic offences or are more involved in traffic accidents than those who are not exposed. Sensitive person-related data are accessed. The drawbacks of this method are the high standards concerning data protection that must be met. Furthermore, it can not be ensured that the patients took the medicines like it was prescribed at the time of the critical event or if they additionally took other psychoactive substances. It can further not be distinguished whether or not the medical condition itself caused the critical traffic event.

3.2 Results from roadside surveys

The methodological issues of roadside surveys were outlined in Chapter 3.1.1. In the present chapter, results from European roadside surveys are shown. Because roadside surveys are a time- and cost-consuming method, they are rather rarely conducted. The following summary is limited to the German Roadside Survey (GRSS) that was conducted by Krüger et al. (1996) and the 13 roadside surveys that were recently conducted within the EU-funded project DRUID (Houwing et al., 2011a; Houwing et al., 2011b).

The GRSS is one of the largest surveys of its kind (Krüger et al., 1996). Over 21,000 drivers were stopped by the police in two adjacent states of Germany (Lower Franconia, Thuringia) in three time periods (1992, 1993, 1994). They were examined by a research team of the university of Wuerzburg, which breath tested the subjects and took saliva samples (saliva samples only in Lower Franconia and only in the first two time periods). Additionally, the drivers were interviewed at site concerning relevant information (i.e. age, gender, driving experience, destination, purpose, presence of passengers, knowledge about laws and sanctions).

In Lower Franconia 6,227 drivers were stopped in the first and the second time period (1992, 1993). The responder rate for the breath tests was 94.7% (N=5,899), for the interviews 92.5% (N=5,760) and for the saliva samples 89.6% (N=5,577). An extended responder analysis did not give evidence that the 10% of drivers that rejected to give a saliva sample refused because they feared to get detected. Especially young drivers agreed to give a sample most often.

The saliva samples were toxicologically analysed for the following core substances: amphetamines, cocaine, THC, opiates (morphine and others), benzodiazepines and barbiturates. The original sample had to be cut down in size because of the following reasons: 1) financial reasons due to high costs concerning the toxicological analyses, 2) not all samples contained enough saliva to get valid results, and 3) not for all drivers all information was available that was necessary to extrapolate the results into representative figures. The frequencies of positive samples within the final sample size of 2,066 were extrapolated by using representative driving data from the German national study on mobility KONTIV 89 (now called MiD). The results are shown in Table 2.

Table 2: Results from the GRSS: German prevalence of psychoactive substances in traffic (in percent, ±0.95 CI; in the case of alcohol, all available samples from Lower Franconia from all three time periods were included in the analysis, N=9,086).

	Prevalence (±0.95 CI)
Alcohol (BAC>0.0%)	5.48 (5.01-5.95)
18-24	3.76 (not available)
25-49	5.48 (not available)
Amphetamines (cut-off: ≥100 ng/ml)	0.08 (0.00-0.21)
Cocaine (cut-off: ≥200 ng/ml)	0.01 (0.00-0.06)
THC (cut-off: ≥20 ng/ml)	0.57 (0.24-0.90)
Opiates (cut-off: ≥100 ng/ml)	0.62 (0.28-0.96)
Illicit opiates (cut-off: ≥100 ng/ml)	0.15 (0.02-0.32)
Medicinal opiates and opioids (cut-off: ≥100 ng/ml)	0.47 (not available)
Benzodiazepines (cut-off: >5 ng/ml / >3 ng/ml)	2.67(1.87-3.47)-3.80 (2.85-4.75)
Barbitures (cut-off: >100 ng/ml)	0.57 (0.22-0.92)

The European research project DRUID consisted of different Work Packages that were aimed at different topics concerning drug driving (e.g. prevalence and risk of psychoactive substances, enforcement, classification of medicines, rehabilitation of offenders, withdrawal of driving licenses; for more information see www.druid-project.eu).

The main objective of Work Package 2 was to assess the situation in Europe with regards to the prevalence and risk of the use of psychoactive substances by drivers. In thirteen European countries, the prevalence of drug driving was estimated by means of roadside surveys (Houwing et al., 2011a; Houwing et al., 2011b): Belgium (BE), Czech Republic (CZ), Denmark (DK), Spain (ES), Finland (FI), Hungary (HU), Italy (IT), Lithuania (LT), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Sweden (SE). In total, around 50,000 drivers were investigated. The non-response rates of the thirteen roadside surveys varied between 0% and 52%.

To be able to compare the prevalences of the different countries, the procedure of the roadside surveys was based on a uniform design as it was shortly outlined in Chapter 3.1.1 (for more details see Houwing et al., 2011a). Furthermore, uniform guidelines regarding the collection, the transport as well as the analysis of body fluids (oral fluid or whole blood) have been derived. Most countries collected solely saliva

samples (9 out of 13 countries). If both, saliva and blood, were taken, the result of the blood analysis was used for the calculation of prevalences. In the case of saliva, equivalent cut-offs to blood were applied. It also was decided that all countries analysed at least a core list of 23 substances, including alcohol, that were further aggregated into substance groups and substance classes[16]. The substance groups as well as the substance classes were mutually exclusive. Some records had to be removed from the database because of the following reasons: 1) sample analysis not available, 2) one or more substance group analyses missing, 3) driver's age 17 years or younger.

The procedure to calculate prevalences was determined beforehand, again, to make sure that the country results were comparable. The frequencies of negative and positive records per investigated time period were weighted according to the distribution of the general traffic volume over these time periods. By logistic regression models, the influence of different independent variables (time period, age of driver, driver gender, country and interactions) on the explanation of the prevalences was shown. The definition of common guidelines could not entirely prevent limitations with regards to representativeness and non-response in the case of some countries. Anyhow, weighted mean European prevalences were calculated to which the prevalences of each country were related to. The mean European values should be used with care. Because only 13 countries were integrated, the European population was not fully represented in the study (Southern EU: 89%, Eastern EU: 63%, Northern EU: 29:, Western EU: 11%).

The findings can be summarised as follows: Alcohol is still the most often found psychoactive substance on European roads, followed by illicit drugs and medicinal drugs. The results showed that the countries with the highest prevalence for alcohol have a legal BAC-limit of 0.04% or higher. However, a direct relationship between the height of the prevalence and the legal BAC limit can not be concluded because other factors possibly influence the prevalence level as well (e.g. general and specific deterrence effect of enforcement; Veisten et al., 2010, cited in Houwing et al., 2011a). In the case of illicit drugs, THC is the most frequently detected drug in traffic, followed by cocaine. Amphetamines and illicit opiates were less frequently detected. Illicit drugs were in general mainly detected among young male drivers during all times of the day but mainly in the weekend. Medicinal drugs were in general mainly detected among older female drivers during daytime hours. Benzodiazepines were the most prevalent medicinal drug in traffic. Z-drugs and medicinal opiates and opioids were in general relatively frequently detected in Northern European countries. Illicit drugs, alcohol and benzodiazepines were often detected in Southern European countries. In Eastern Europe, the prevalence of alcohol and drugs was relatively low compared to the other European regions. In Western Europe, drug driving turned out

[16] 23 core substances: ethanol, 6-acetylmorphine, alprazolam, amphetamine, benzoylecgonine, clonazepam, cocaine, codeine, diazepam, flunitrazepam, lorazepam, MDA, MDEA, MDMA, methadone, methamphetamine, morphine, nordiazepam, oxazepam, THC, tramadol, zolpidem, zopiclone.
Substance groups: negative, amphetamines, cocaine, THC, illicit opiates, benzodiazepines, Z-drugs, medicinal opiates and opioids, alcohol, alcohol-drugs or drugs-drugs.
Substance classes: negative, alcohol, illicit drugs, medicinal drugs, alcohol-drugs, drugs-drugs.

to be more or less on the European average. The European prevalences found within Work Package 2 of DRUID are shown in Table 3 (Houwing et al., 2011a).

Table 3: Results from DRUID: European prevalences of psychoactive substances in traffic (±0.95 CI, N=48,542; Houwing et al., 2011a).

		Negative	Amphet-amines	Cocaine	THC	Illicit opiates	Benzo-dia-zepines	Z-drugs	Med. opiates and opioids	Alcohol	Alcohol-drugs	Drugs-drugs
Northern Europe	DK	95.52 94.72-96.2	0.02 0-0.16	- -	0.2 0.09-0.43	- -	0.47 0.28-0.79	0.32 0.17-0.59	0.79 0.53-1.18	2.53 2.02-3.15	0.1 0.03-0.3	0.06 0.02-0.24
	FI	97.15 96.58-97.63	0.05 0.02-0.19	0.03 0.01-0.16	0.04 0.01-0.17	- -	0.79 0.56-1.13	0.36 0.21-0.6	0.56 0.37-0.85	0.64 0.43-0.94	0.08 0.03-0.23	0.29 0.16-0.52
	NO	97.03 96.67-97.36	0.06 0.02-0.13	0.06 0.03-0.14	0.48 0.36-0.64	- -	0.84 0.67-1.05	0.69 0.54-0.88	0.16 0.1-0.27	0.32 0.23-0.46	0.07 0.03-0.15	0.28 0.19-0.42
	SE	98.66 98.34-98.92	0.07 0.03-0.17	- -	0.03 0.01-0.12	- -	0.19 0.11-0.33	0.31 0.2-0.48	0.63 0.46-0.86	NA	NA	0.12 0.06-0.25
Total N-EU		97.32	0.05	0.02	0.16	0.00	0.51	0.40	0.56	1.20	0.05	0.17
Eastern Europe	CZ	97.2 96.39-97.83	0.36 0.17-0.72	- -	0.46 0.25-0.86	- -	0.62 0.36-1.07	- -	0.21 0.08-0.52	0.99 0.65-1.53	0.05 0.01-0.28	0.11 0.03-0.38
	HU	97.68 97.04-98.18	- -	0.04 0.01-0.21	0.19 0.08-0.44	- -	1.5 1.11-2.03	0.07 0.02-0.26	0.11 0.04-0.32	0.15 0.06-0.38	- -	0.27 0.13-0.54
	LT	94.49 93.09-95.61	0.22 0.07-0.66	- -	- -	- -	1.41 0.9-2.23	- -	- -	3.86 2.93-5.06	0.03 0-0.36	- -
	PL	97.63 97.11-98.05	0.05 0.01-0.18	- -	0.57 0.38-0.85	0.09 0.04-0.25	0.14 0.06-0.31	- -	0.03 0.01-0.15	1.47 1.14-1.9	- -	0.02 0-0.14
Total E-EU		97.57	0.09	0.01	0.47	0.06	0.52	0.02	0.08	1.10	0.01	0.07
Southern Europe	ES	85.15 83.87-86.34	0.11 0.04-0.3	1.49 1.12-1.97	5.99 5.22-6.87	0.05 0.01-0.2	1.4 1.05-1.87	- -	0.19 0.09-0.41	3.92 3.3-4.66	1.14 0.83-1.58	0.57 0.36-0.89
	IT	84.99 82.95-86.82	- -	1.25 0.78-2.01	1.15 0.7-1.89	0.3 0.12-0.78	0.97 0.57-1.67	- -	0.53 0.25-1.09	8.59 7.19-10.23	1.01 0.59-1.71	1.22 0.75-1.97
	PT	90.01 89.04-90.91	- -	0.03 0.01-0.16	1.38 1.07-1.8	0.15 0.07-0.33	2.73 2.27-3.29	- -	0.11 0.04-0.27	4.93 4.29-5.64	0.42 0.26-0.67	0.23 0.12-0.44
Total S-EU		85.52	0.04	1.23	3.06	0.19	1.30	-	0.36	6.43	1.01	0.87
Western Europe	BE	89.35 88.18-90.41	- -	0.2 0.09-0.43	0.35 0.19-0.64	0.09 0.03-0.28	2.01 1.57-2.59	0.22 0.1-0.47	0.75 0.5-1.13	6.42 5.59-7.36	0.31 0.16-0.58	0.3 0.16-0.58
	NL	94.49 93.81-95.1	0.19 0.1-0.36	0.3 0.18-0.5	1.67 1.34-2.07	0.01 0-0.09	0.4 0.25-0.62	0.04 0.01-0.15	0.16 0.08-0.32	2.15 1.78-2.6	0.24 0.13-0.42	0.35 0.22-0.56
Total W-EU		92.46	0.12	0.26	1.15	0.04	1.03	0.11	0.39	3.83	0.27	0.33
Weighted European mean		92.57	0.08	0.42	1.32	0.07	0.90	0.12	0.35	3.48	0.37	0.39

3.3 Results from interviews

Like mentioned in Chapter 3.1.1, interviews entail the most diverse possiblities to gather information about the frequency and the circumstances of DUI. In the following, the results of a study by Vollrath et al. (2001) are shortly outlined to show the magnitude of information that can be gathered by interviews (like sociodemographic characteristics, health consciousness, personality traits, alcohol/drug consumption, attitudes, perception of state-run deterrence measures). There are many studies to be found in the literature that apply interviews and questionnaires to collect data about the phenomenon drug driving (in Germany, e.g. Widera 2003). To some, it will be referred to in Chapter 5 when it comes to depict the selection of person-related variables that are associated with drug driving. To some extent, the questions chosen for the present study where phrased in accord with the German study by Vollrath et al. (2001).

The study was conducted in 1998. 2,555 drivers were interviewed in selected clubs in Bavaria, Germany. 503 persons were selected and further investigated according to the information that they gave regarding their drug consumption. The in-depth investigation consisted of a driving simulator task, a detailed interview and the collection of body fluids. Vollrath et al. (2001) aimed at describing different influencing factors and the risk potential of driving under the influence of drugs. The interview was aimed at identifying social, person-related and legal factors that influence the decision to drug drive. Further on, it was of interest if the decision to drug drive differs from the decision to drink and drive. The following summary of the main results is focused on the findings that refer to drug intake and drug driving. The results concerning alcohol are only listed if distinct differences between drugs and alcohol were found. In most of the analyses, the alcohol-related results go in the same direction as for drugs, although they are less pronounced.

Of 483 mainly male drivers who were aged 18 to 30 years and who were either alcohol/drug users or non-users, interview data were available. 135 subjects stated to not use drugs. The remaining subjects were classified as light cannabis users (low use), heavy cannabis users or cannabis users with concomitant use of stimulants (medium use), and persons who mainly use hard drugs (high use). 85.3% of the drug using subjects stated to drive after the consumption of drugs, while 14.7% said they would not.

Vollrath et al. (2001) found relatively high levels of education, low unemployment, good social integration and intact family relations within the sample of drug users. Younger subjects were found to consume drugs more and alcohol less often than older subjects. Males stated a higher general alcohol consumption than females, while no difference was found for drug consumption. Females used drugs as often and to the same extent as males.

The extent to which someone uses drugs is linked to the occurrence of DUI. The higher the consumption is, the higher is the probability that someone drives under influence. Anyhow, there are many subjects within the sample of heavy alcohol users in contrast to heavy drug users who do not drive while under influence. The authors conclude that drink driving is regarded as more condemnable than drug driving and is therefore more likely left undone.

It turned out that personality traits are more often linked to the decision to take drugs rather than to the extent of substance use and the decision to drive under influence. The only personality trait that distinguished drug drivers from drug users who do not drug drive was sensation seeking. Here, drug drivers were found to have higher scores. In terms of personality, it was also shown that drug users differ from non-users to a higher degree than alcohol users. They were found to be more willing to take risks, are more extraverted, more emotional unstable as well as socially maladjusted. As taking drugs is illegal, drug use as compared to alcohol use requires to exceed a high social threshold and is, therefore, thought to be more dependent on personality features.

The authors also showed that if someone uses drugs, and especially if someone uses drugs to a high degree, the person is less concerned about health issues and also more involved in the consumption of legal drugs. Using drugs is also associated with a social environment in which drug use is more common than in the social life of persons who do not take drugs.

The decision to use drugs, a high extent of consumption as well as the decision to drive under influence contribute to more permissive attitudes concerning driving under the influence of drugs, especially in contrast to driving under the influence of alcohol. A relation to the subjects' statements concerning peers' attitudes towards drug driving and peers' drug driving behaviour was also found. In the case of drugs, the decision to use drugs and to drive under influence are more associated with peers' attitudes and behaviour than the extent to which they use drugs. A higher peer orientation for those subjects who drink drive compared to those who do not was found. This might be an indicator for a high influence of co-drivers on the driver's decision in the case of drink driving.

With reference to deterrence measures, it was shown that the subjective stopping and detection probability is in accord with the subjects' own experiences. Subjects who have ever been detected while driving under influence delivered higher ratings concerning subjective stopping and detection probability than those who were not.

4. Smartphones as study devices

4.1 Methodological issues of field research

The most often applied and the most economical method of psychodiagnostics are self-reports by questionnaires and interviews (Wilhelm & Perrez, 2001). Therein, subjects have to give either global self-ratings or make retrospective statements about their experiences and behaviour in a more or less specific context and time frame. The basic problem that is inherent in retrospective reports are memory distortions and biases in judging past experiences (Reuschenbach & Funke, 2011; Hufford, Shiffman et al., 2001). Not the experience and behaviour itself is recorded but the cognitive representation of it (Fahrenberg et al., 2007). To provide accurate information, the respondent must comprehend the questions, recall information from memory, make decisions about the accuracy of the information and format an answer (Jobe, 2000). Errors are possible at each of these cognitive tasks. Moreover, the validity of self-reported data is even more questionable if sensitive and highly stigmatised behaviours such as drug use are surveyed (Harrison & Hughes, 1997). Empirical investigations of this issue have demonstrated that most validity research, in fact, shows quite high congruence rates between self-report and assay results (Harrison, 1997). Cook, Bernstein and Andrews (1997) found that self-reports produced slightly higher prevalence rates than either urinanalysis or hair analysis. Anyhow, biological data can be prone to false positives, false negatives and other inaccuracies as well (Turkkan, 2000).

In laboratory studies, experiences and behaviour are prompted and directly recorded in artificial settings. Compared to laboratory research, methods of recording psychological data in everyday life enable the assessment of ongoing emotions, cognitions and behaviour, together with actually existent context information, antecedents and consequences in naturalistic and unconstrained settings (Wilhelm & Perrez, 2001). So, ecological validity and, thus, practical utility that are often claimed to be missing in artificial laboratory settings are given in this so-called field studies.

Field studies are characterised by the following (Wilhelm & Perrez, 2001):

1) The setting is not arranged by the researcher
2) The observed behaviour or experience is natural, i.e. not instructed
3) The behaviour or experience is recorded directly or after minimal time difference to the actual behaviour or experience

Concerning ecological validity, these characteristics are major advantages in contrast to laboratory studies and retrospective data collection. On the other hand, no exact variation of conditions can be produced nor can confounders be controlled for, which restricts the internal validity. Anyhow, because relevant context information, i.e. the setting and situational aspects (Fahrenberg, 1996), can also be recorded in field

studies, everyday life produces itself natural conditional variations that can be used (Fahrenberg et al., 2007).

Different methodologies of field research can be distinguished (Wilhelm & Perrez, 2001):

1) Self-observation versus observation of others (in the field or based on recordings) versus monitoring (by portable recording systems) of biological signals (e.g. blood pressure) or behavioral parameters (e.g. voice, movement)
2) Time- versus event- versus interval-sampling (see also Baumann, Feichtinger, & Thiele, 2001; Wheeler & Reis, 1991; Shiffman, 2000)

Time-sampling characterises data collection that is triggered by the occurrence of a particular event. So, the data collection is event-controlled. All events within a certain time period are recorded. This method especially is appropriate if a specific behaviour or seldom events are studied and if variations of an event are of interest. In contrast to that, *event-sampling* stands for records that are made according to a randomised or set time sampling schedule. So, the data collection is time-controlled, e. g. a beeper prompts the subject to respond to a questionnaire. Here, the relative distribution of a behaviour is of interest. The frequency and patterns of behaviour can be estimated. *Interval-sampling* describes observation techniques that continuously record behaviour in a certain period of time. Participants report their experiences at regular, predetermined intervals. Typically, these intervals represent theoretically or logically meaningful units of time, e.g. at the end of each day. The reports usually refer to what has happened since the previous interval. This method integrates the advantages of time- and event-sampling: all events that occurred within the study period are gathered (time-sampling); if the time-units are chosen properly according to the incidence of the behaviour, it can also be used to make assumptions about the distribution of the behaviour over time and behavioural patterns (event-sampling).

4.2 New developments in field research

Recently, advances in technology in real-time data collection have multiplied the potentialities of field studies. Tape recorders and event recorders have been superseded by more advanced instrumentation that electronically collect and save data (Buse & Pawlik, 2001, Fahrenberg, 1996).

Simultaneously, the term “ambulatory assessment” or “ecological momentary assessment“ developed in the field of field research (Reuschenbach, 2006; Fahrenberg et al., 2007). It combines the different research orientations and methods of traditional field research, behavioural assessement, clinical monitoring, ambulatory monitoring and biotelemetry (Fahrenberg, 1996). Ambulatory assessment involves the acquisition of psychological data and/or physiological measures in everyday life, i.e. natural settings, together with relevant context information. Common features are: recordings in everyday life, computer-assisted methodology, attempts to minimise method-dependent reactivity and maintaining ecological validity (Fahrenberg, 1996; Fahrenberg et al., 2007).

So, by ambulatory assessment or ecological momentary assessment, a wide variety of phenomena can be studied. Reuschenbach and Funke (2011) show different psychological studies that applied ambulatory assessment strategies to study different psychological constructs. Fahrenberg et al. (2007) list typical hypotheses that can be examined by these methods. Hufford et al. (2001) also show the broad applicability of the ambulatory assessment methods by referring to a wide variety of different studies in which these methods were used.

4.3 Computer-assisted self-reports

The recording of psychological data in everyday life became much easier through the availability of pocket-sized computers (i.e. personal digital assistant, PDA) or mobile phones with full PDA functionality (i.e. smartphones). Suitable PDAs or smartphones have sufficient memory capacity, a clock, an electronic beeper, an operating system that allows for flexible programming and a display to present questions and rating scales or multiple-choice items, which can be answered by pressing a key, moving a cursor or track-wheel or typing a response (Fahrenberg, 1996).

The application of programmable PDAs and smartphones in ambulatory assessment has many advantages (Wilhelm & Perrez, 2001; Fahrenberg, 1996; Fahrenberg et al., 2007)

1) Alarm functions or a reminder signal for prompting the subject at predefined intervals; this enables the avoidence of omissions and the optimisation of the representativity of the event sample
2) System-controlled feedback or system-locks in the case of missings or logical data inconsistencies
3) Reliable timing of input, delay of input and duration of input; this enables the exact control of compliance
4) Flexible layout of questions and response categories, branching of questions and an adaptive hierarchical structure of the questionnaire; this enables the collection of very detailed information
5) Previously recorded responses are concealed; so, responses can not be subsequently inspected by the subjects or others
6) Digital data transfer to the computer prevents from additional coding errors, additional costs and enables immediate processing of the data

An exciting prospect of applying handheld computers is the possibility to link them to ambulatory physiological data collection devices (Hufford et al., 2001). Furthermore, today's pocket-sized computers also allow for programming of performance tests by displaying it on the screen (Buse & Pawlik, 2001; Fahrenberg et al., 2007). This enables a promising combination of field and laboratory research methods.

The handling of the PDA or smartphone device requires training. Anyhow, it has to be considered that some populations, like elderly or patients with sensory or motor disorders, might have problems (Fahrenberg, Hüttner, & Leonhart, 2001). Besides, the questionnaire, its items and categories should be explained in detail. An in-depth

training may be needed if complex data have to be reported. However, the programme should also control data for operating errors (Fahrenberg, 1996).

In general, the quality of self-report data is heightened by using PDAs or smartphones because self-administered questionnaires can be applied instead of interviews in which the respondents must speak their responses aloud (Lessler & O'Reilly, 1997). So, on the one hand, ambulatory assessment enhances privacy. On the other hand, the use of electronic recording systems violates privacy more easily than other methods because more parameters can be recorded in more detail within the natural setting (Fahrenberg, 1996). Therefore, it is essential to obtain informed consent and to inform the subjects about data privacy issues before recording starts. Besides, the subjects have to be assured of the possibility to decide in the end if they allow the use of their data (Fahrenberg et al., 2007). Bersoff and Bersoff (2000) claim that subjects should get informed about 1) the topic and the purpose of the research, 2) the nature of the questions that are asked, 3) the time that is required for the participation, 4) their right to skip individual questions or to withdraw from the study at any time without penalty, 5) the limits of the confidentiality of the collected data, and 6) who they can contact if they have any concerns of questions regarding the study.

The acceptance of computer-assisted assessment is usually unproblematic and compliance rates are high (Fahrenberg, 1996, Fahrenberg et al., 2007; Helbig, Lang, Swendsen, Hoyer, & Wittchen, 2009). Anyhow, compliance and thus data quality can be raised if subjects are aware that their compliance is tracked, if they are aware of external checks of their self-reports (e.g urine samples in the case of drug use), if good rapport between the interviewer and the respondent can be established, if subjects receive feedback, if they get rewarded by incentives and if subjects are not overburdened by a high frequency and/or complexity of required protocols. The question length and response modeling should be carefully considered. It is important to avoid free text self descriptions. The diary style should be structured according to the theoretical framework in order to collect only relevant data (Hufford et al., 2001; Perrez, Wilhelm, Schoebi, & Horner, 2001; e.g. Cannell, Miller, Oksenberg, 1981, Nurco, 1985, cited in Sherman & Bigelow, 1992).

Another hypothesised challenge is the potential distortion of data by reactivity. A reactive effect describes the degree to which a target variable will change when being observed (Nelson & Hayes, 1981). Some studies examined this issue but failed to find evidence that self-monitoring approaches produce significant reactivity (Cruise, Broderick, Porter, Kaell, & Stone, 1996; Peters et al. 2000). Anyhow, an increased state of self-awareness (Carels, Douglass, Cacciapaglia, & O'Brian, 2004) or distinct avoidance behaviour may change the behaviour that is under investigation (Fahrenberg et al., 2001, Fahrenberg et al., 2007). A study by Harris and Miller (1990) showed that no reactive effects can be found when studying problem drinkers who self-monitor their drinking behaviour. Schroder & Perrine (2007) suggest longer study periods because reactivity is more likely to occur during the initial phase of a longitudinal study.

Even though the time delay between the actual occurrence of an event and its reporting can be minimised in computer-assisted field studies, a specific retrospection ef-

fect is sometimes accepted (Fahrenberg et al., 2001) by allowing a time delay between occurrence of event and reporting (e.g. daily report in the evening or next morning). Käppler, Becker and Fahrenberg (1993, cited in Fahrenberg et al., 2001) compared the averages of self-ratings, which were recorded at intervals of about 30 minutes, with the summarising retrospective ratings, done next morning from memory. The retrospective ratings indicated more negative mood and unease than was to be expected from the actual ratings averaged across the day, that is, a negative retrospection bias. But Reuschenbach and Funke (2011) as well as Shiffman (2000) claim that biases most often occur when global self-ratings are asked for (e.g. “How often do you usually drink alcohol”) and are less expected when episodic information has to be recalled (e.g. “How much alcohol did you drink at the last party?”). Thus, it should be carefully reconsidered, depending on the aim of the study, the complexity of the protocols, the capacity of the subjects and the content of the questions, when and how often it is reasonable to prompt subjects to fil in a protocol.

The type of data collected by computer-assisted field methods can pose data management and analysis challenges. A relatively simple design prompting 100 subjects 5 times per day for a brief 10-item assessment over a 3-week period will produce 105,000 data points. The data can be analysed on intra- or inter-subject level (Helbig et al., 2009). For this purpose, sophisticated analytic approaches have been developed (Schwartz & Stone, 1998; Wilhelm, 2001).

The use of PDAs and smartphones must also be balanced against the financial commitment that is faced when using a high level of technological innovation. Furthermore, it has to be considered that the user-interface and other programming issues have to be adequately addressed to avoid high rates of failure and poor subject compliance (Hufford et al., 2001).

5. Person-related variables associated with DUI

In the following chapter, findings and theories are presented that support and suggest the influence of different driver-related characteristics on the occurrence of drug driving. The characteristics are summarised in the categories sociodemographic variables, personality traits, mental diseases, social influences, attitudes and perceived risks.

5.1 Sociodemographic variables

Sociodemographic variables comprise a wide variety of person-related variables[17]. When it comes to illicit drugs, most of the studies on drug driving have revealed a higher incidence among young people while driving under the influence of medicinal drugs has been found to be more common in older drivers (see Kelly, Darke, & Ross, 2004; Drummer, Gerostamoulos, & Batziris, 1998, cited in Davey, Davey, & Obst, 2005). Males have been found to be over-represented among illicit drug users and more likely to engage in risky driving behaviours like drug driving (see Kelly et al., 2009; Harre, Field, & Kirkwood, 1996, Hunter, Lokan, Longo, White, & White, 1998, cited in Davey et al., 2005). On the other hand, there is evidence that drug driving prevalence among females has increased in recent years (Skurtveit, Christophersen, Morland, 1995, cited in Kelly et al., 2004). Those who are convicted of drink driving are found to be generally over-represented in terms of lower socioeconomic background, unemployment and limited education (see Kelly et al., 2004). There is also some evidence that drug driving is associated with limited education (see Kelly et al., 2004; Walsh & Mann, 1999, cited in Karjalainen et al., 2011) and other factors that indicate lower socio-economic position (e.g. unemployment, being divorced, living alone; Karjalainen et al., 2011), but findings are ambiguous (cf. Vollrath, 2001). Anyhow, it seems likely that poor social functioning is due to substance use and, thus, only indirectly related to drug driving (Kelly et al., 2004).

5.2 Personality traits

The literature was reviewed for psycho-social factors that predict drug driving. Few findings report direct associations of psycho-social factors to drink or drug driving. Instead, factors are found that are associated with risky behaviour in general (risky driving, substance use, crash rates, DUI arrests, etc.).

[17] E.g. gender, age , residence, marital status, nationality, religious affiliation, household size, children, education, employment status, income, social environment, socio-economic status.

Jonah (1997) reviewed the literature on sensation seeking and risky driving. Of 18 studies, all but five found a positive relationship. Few studies compared the subscales of the sensation seeking scales (SSS). The Disinhibition subscale correlates most strongly with drinking and driving, whereas the Thrill and Adventure Seeking Scale (TAS) has the strongest relationship to risky driving.

Caspi et al. (1997) found that undercontrolled (i.e. irritable, impulsive, impersistent) 3-year-old children are low on the Constraint scale (i.e. disposed to act on impulse, take risks, ignore conventional restrictions) and high on the Negative Emotionality scale (i.e. proneness to experience anxiety, anger, related emotional and behavioural negative engagement) of the Multidimensional Personality Questionnaire (MPQ) by Tellegen (1982) at age 18. They are more likely to be involved in more health-risk behaviours (including drinking and driving) at age 21. Ryb, Dischinger, Kufera and Read (2006) also found that, in addition to low risk perception, high impulsivity is associated with risky behaviours (including drinking and driving). A relationship between drug use and AD(H)D, which is distinguished by a high level of impulsivity, is often referred to in the literature. Miller and Blum (1996) found that AD(H)D in childhood often leads to drug-abuse or -dependence in adolescence and adulthood. Besides impulsivity, the relieving effects of some drugs on AD(H)D might be the reason. Zeberlein and Küfner (2003) stated common drug use as self-medication for AD(H)D symptoms. Adriani, Caprioli, Granstrem, Carli and Laviola (2003) found that acute administration of a cannabinoid agonist normalised the impulsive behavioural profile in hypertensive rats without any effect on rats within a control group. Furthermore, amphetamine is commonly used as prescribed medication for AD(H)D.

Armstrong, Wills and Watson (2005) found that those who perceived more social and non-social rewards than punishments associated with drug driving, were more likely to engage in the behaviour. Referring to this, the sensitivity to punishment and to reward could have a moderating effect. Gray (1972, 1981) described two motivational systems, the Behavioural Inhibition system (BIS) and the Behavioural Activation system (BAS) that control aversive and appetitive behaviour, respectively. The BIS is related to the trait-anxiety dimension and is highly associated with high sensitivity to non-reward and punishment, whereas the BAS is related to the impulsivity dimension of personality and is highly associated with high sensitivity to reward and to non-punishment. Castellà and Pérez (2004) studied the relationship between traffic offences and sensitivity to reward and punishment. People with high scores in sensitivity to punishment and low ones in sensitivity to reward drove lawfully, while those with low sensitivity to punishment and high sensitivity to reward broke the law more often.

Kaplan's self-derogation theory of delinquency (Kaplan, 1975) is based on the assumption that all persons have a basic need to think well of themselves and to avoid negative self-evaluations. Kaplan stated that adolescents with low self-esteems and low social competence are motivated to take action to restore positive self-regard by unlawful behaviour. When low self-esteem and rejection by conventional reference groups is experienced, individuals are likely to join unconventional, delinquent peers and involve in unlawful behaviour.

Locus of control can be defined as a personality trait that reflects the degree to which a person generally perceives events to be under their own control (internal locus of control) or under the control of powerful others or other outside forces (external locus of control) (Rotter, 1966). Several researchers (e.g. Hoyt, 1973) suppose that an external locus of control is related to a lack of caution and failure to take precautionary steps to avoid the occurrence of unfavourable outcomes. Hence, it has been hypothesised that external locus of control might be related to less responsible driving and accidents.

In a literature review by Donovan, Marlatt and Salzberg (1983), social stresses have been found to be related to drinking episodes that eventuate in DWI arrests. Even if the frequency of stressful events was not higher, arrestees reported a significantly higher level of subjective distress associated with the occurrence of the events than those who were not arrested (Selzer & Barton, 1977, Selzer, Vinokur, & Wilson, 1977, cited in Donovan et al., 1983).

5.3 Mental diseases

Darke, Kelly and Ross (2004) found that recent drug drivers had significantly higher levels of dependence, higher frequencies of drug use and more extensive polydrug use. Lapham et al. (2001) stated that an examined DWI offender population has high rates of alcohol/drug-use disorders and that offenders with alcohol-use disorders often have additional psychatric disorders, mainly posttraumatic stress disorder or major depression. Shaffer, Nelson, LaPlante, LaBrie, Albanese and Caro (2007) showed higher prevalences of alcohol/drug-use disorders, conduct disorder, post-traumatic stress disorder, generalised anxiety disorder and bipolar disorder among repeat DUI offenders compared with the general population. Moeller, Barratt, Dougherty, Schmitz and Swann (2001) as well as Swann, Bjork, Moeller and Dougherty (2002) stated that impulsive individuals are prone to substance abuse and dependence (see Chapter 5.2) and that impulsivity is also a symptom of psychiatric disorders, including attention deficit/hyperactivity disorder (AD(H)D), borderline personality disorder and bipolar disorder).

5.4 Social influence

Social learning and Social Control Theory stress the influence of parents and peers on the development of problematic behaviour (Bahr et al., 2005). It has been hypothesised that family and friends can have an influence on drug use or driving behaviour of a person. Within families where e.g. alcohol is used, adolescents may observe alcohol use, acquire favourable attitudes towards alcohol use and begin using alcohol themselves (Wills, Mariani, & Filer, 1996, cited in Bahr et al., 2005). Similarly, if their friends drink alcohol, take drugs or commit DUI, adolescents are likely to receive positive social reinforcement from their friends for the same behaviour (Petraitis, Flay, & Miller, 1995, cited in Bahr et al., 2005). Besides social learning, social control theory also tries to explain a person's deviant behaviour by

social factors. According to social control theory, every person has the impulse to act deviant and would do so if no social controls by families and other social institutions would hinder the person from doing so (Hirschi, 1969, cited in Bahr et al., 2005). So, if a person has a close relation to the parents, it is thought that they feel obliged to act in a way that pleases parents. In a similar way, monitoring by parents may influence deviant behaviour. When monitoring is high, teens may act in pro-social ways because they know they are watched and judged by their parents (Bahr, Maughan, Marcos, & Li, 1998, Hirschi, 1969, cited in Bahr et al., 2005).

5.5 Attitudes and perceived risks

Based on Fishbein and Ajzen's (1980) theory of reasoned action, attitudes and subjective norms predict behavioural intention and actual behaviour. This theory claims that the way in which people behave is influenced by their behavioural intention. Behavioural intentions, in turn, are influenced by the extent to which someone evaluates a behaviour as positive (attitude) and thinks significant others want the person to perform the behaviour (subjective norm). Several studies have found evidence for a positive relationship between attitudes/believes and behavioural intentions/actual behaviour for driving under influence (Vollrath, 2001; see Albery, Strang, Gossop, Griffiths, 2000; see Davey et al., 2005).

Ajzen's (1985) theory of planned behaviour, which was developed from the theory of reasoned action (Fishbein & Ajzen, 1980), adds the concept of perceived behavioural control. Thus, an individual's perceived ease in performing a behaviour may increase the likelyhood that the behaviour is shown. In the case of driving under influence, the subjective feeling of impairment, the perceived risk of detection or control believes in general (internal locus of control versus external locus of control according to Rotter, 1966) might influence behaviour in this way.

Especially in the field of prevention, the theory of reasoned action and the theory of planned behaviour have been used for designing programmes and strategies aimed at reducing health risk behaviour (National Campaign Against Drug Abuse, 1990, cited in Davey et al., 2005; Tensil & Strüber, 2010; Di Franco, 2007).

Albery and Guppy (1995) found that those who perceived safe alcohol consumption levels to be higher than the one that is required to break the law stated reduced moral commitment concerning drink driving. It was shown that drivers with larger safe, as opposed to legal, estimates report more drink driving occasions and also higher alcohol consumption before their last drink driving trip than other drivers. In a study by Darke et al. (2004), injecting drug users perceived alcohol to be the most dangerous substance for driving and cannabis the least dangerous. Recent drug drivers also perceived drug driving to be less dangerous than those who currently did not drive under influence.

Albery et al. (2000) deduce different explanations for a more permissive perception of impairing and accident-causing effects of drugs on driving skills by drug drivers as compared to non-drug drivers. Besides positive attitudes and the absence of

experienced adverse events (e.g. accident, detection), the authors state that driving after taking drugs creates experienced-based knowledge and a more accurate perception or judgement of the impairing effects of various illicit drugs. It is well documented that alcohol and cannabis affect numerous driving-related skills in a dose-dependent manner (Ogden & Moskowitz, 2004, Ramaekers, Berghaus, van Laar, & Drummer, 2004, Sewell, Poling, & Sofuoglu, 2009, cited in Mc Guire, Dawe, Shield, Rehm, & Fischer, 2011). However, whereas impairment that is caused by alcohol has been demonstrated at very low levels of blood alcohol concentration (Wals & Mann, 1999, cited in Mc Guire et al., 2011), some drivers have been reported to compensate for psychomotor deficiencies after the consumption of low doses of cannabis (Sewell et al. 2009, cited in Mc Guire et al., 2011).

The finding that being under the influence of alcohol while driving is evaluated as more detrimental to traffic safety as any other drug (Albery et al., 2000) could also be due to the fact that deterrence based initiatives concerning alcohol in contrast to drugs have been constant components in road safety programmes.

In basic terms, deterrence theory proposes that an individual will refrain from driving while intoxicated if the perceived chances of experiencing severe sanctions are high, if they are delivered efficiently as well as with a high degree of celerity (Paternoster et al., 1982, cited in Albery & Guppy, 1995). Perceptions of certainty, celerity and severity are conditional on the intensity and effectiveness of enforcement (Taxman & Piquero, 1998, cited in Watling, Palk, Freeman, & Davey, 2009) as well as on a high level of publicity of sanctioning and enforcement (Elvik & Christensen, 2007, cited in Watling et al., 2009). Research has, however, consistently shown that, when studied isolated, certainty and celerity of punishment remain important inhibitors of behaviour, whereas severity of punishment (e.g. imprisonment, heavy fines) is less influential (see Ross, 1992; Homel, 1988, cited in Albery & Guppy, 1995).

EMPIRICAL PART

6. Study design

The intention of the survey was to combine driving and drug use behaviour of a sample drawn from the general population in order to make assumptions about the frequency and the circumstances of drug driving. The intended sample should reflect the population of interest as close as possible to be able to make generally valid statements about drug driving incidences. In order to reach the demand for representativity of the sample, the following considerations were taken into account:

- The whole population consists of drivers and non-drivers. To make general assumptions about driving, the sample needs to be drawn from the driver population
- The whole population consists of drug users and non-users. To make general assumptions about drug use, the sample needs to be drawn from the user population
- The closest representation of the real amount of driving and drug use will be achieved by sampling those persons who show the behaviour of interest frequently. Persons who drive or use drugs rather infrequently only account for a little proportion of the whole phenomenon and are therefore negligible. The chance to drive under the influence of drugs is minimised as soon as the person practically never or almost never drives or uses drugs.
- According to representative data about driving behaviour in Germany (MID 2008) up to 80% of all drives are travelled by persons who drive daily or weekly. According to representative data about drug use in Germany (ESA 2006), the highest prevalence rates for current drug use are found for the population of 18-39-year-olds[18]. The population of 18-39-year-old persons who use drugs on a regular basis (defined as >3x in 30 days) accounts for around 80% of all drug incidences.

After these considerations, the inclusion criteria were determined as follows.

- Age 18-39
- Availability of a vehicle and weekly driving
- Weekly drug use

There is clear evidence that characteristics of driving strongly depend on gender, age and residence (MiD 2008). The same holds true for the consumption of psychoactive

[18] 30-days-drug-prevalence for different age categories: 9.2% (18-20-year-olds), 8% (21-24-year-olds), 5.1% (25-29-year-olds), 3% (30-39-year-olds), 1.2% (40-49-year-olds), 0.3% (50-59-year-olds), 0% (60-64-year-olds).

substances, at least for the factors age and gender (ESA 2006). To cover the whole population of interest, the sample was stratified concerning these variables.

The stratification variables were determined as follows:

- Age group: 18-24, 25-29, 30-39
- Gender: Male and female
- Residence: Rural (<50,000), urban (<500,000), city areas (>500,000)

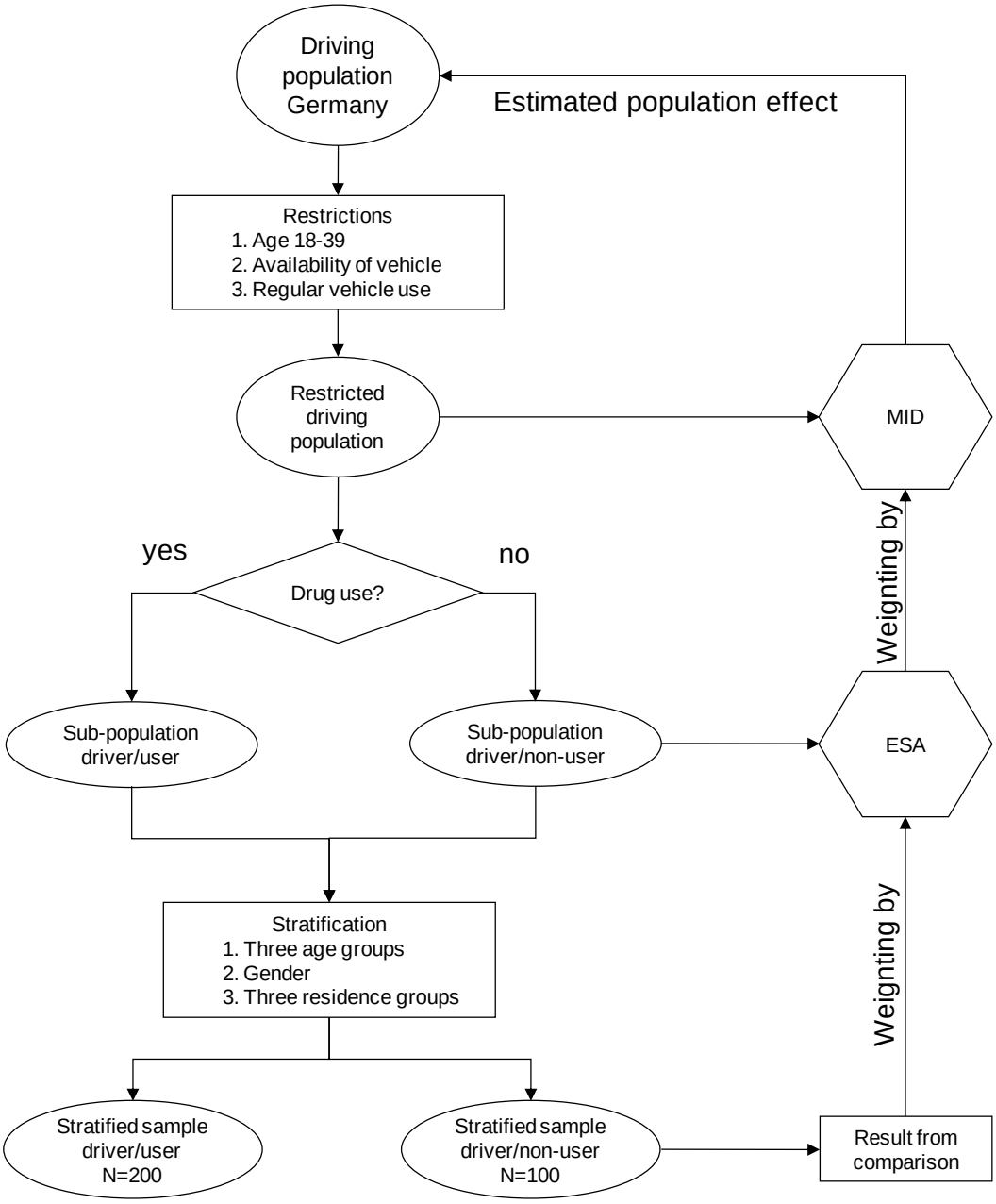


Figure 1: Overview over the study design.

For every second drug user, a paired control was admitted to the study. The pairs were matched based on the variables gender, age and residence. Thus, for the control group the same sample structure was realised as for the user group.

On the supposition that the sample corresponds to the population of interest on the relevant variables, the results of the survey can be extrapolated into representative figures. Existing national mobility and drug use data that were referred to earlier (MiD 2008, ESA 2006) served as a database from where weights were deduced from to estimate the proportion of drives that are travelled by persons who regularly drive and regularly use drugs.

By the realisation of this design (Figure 1), three main questions can be answered:

- Are there any differences between drug users and non-users concerning driving and alcohol consumption?
- How high is the prevalence for DUI in the general population, estimated on the basis of the results of this survey?
- Under which circumstances does DUI occur?

7. Sample

7.1 Sample design

The sample in the present study was stratified on the variables gender, age and residence, which were assumed to serve as confounders for driving and drug use, respectively. The target sample size was 200 drug users (mainly cannabis users) and 100 paired controls (no use of illicit drugs, alcohol consumption allowed; matching based on gender, age and residence) recruited from rural, urban and city areas in Bavaria (Wuerzburg, Munich and respective environs). The originally intended sample size was larger. But because of limited time and financial resources, a final sample size of 300 subjects was realised. In epidemiological studies, a higher number of controls than cases is used in general. This helps to increase the power of the design. In the present study, a new methodological approach was introduced with the focus on detailed information about drug use and driving behaviour of drug users. For the purpose of comparing the driving and alcohol use behaviour between users and controls, the relatively low number of controls was considered as sufficient – especially because the controls were matched on all relevant variables. So, more resources could be spent to investigate the main object, i.e. the behaviour of drug users.

Inclusion criteria were age 18 to 39 years, having a car always/sometimes available and using it weekly (i.e. on 1-2 days a week; the cut off was less than seven days in four weeks), regular drug use (i.e. once a week; the cut off was less than three days in four weeks) for users and no drug use within the last year for controls.

From existing population data (Statistical Yearbook 2009; Destatis, 2009), mobility data (MiD 2008) and drug prevalence data (ESA 2006) of Germany, percentage values were deduced for the general German population to estimate the size of the population in each stratum. Because the recruitment of the subjects was constrained to Bavaria (Wuerzburg, Munich and surrounding environs), the corresponding percentage values for the general Bavarian population were also calculated (Table 4).

Within the 18-39-year-old German population 85.1% drive regularly and 2.8% use drugs at least once a week. In Bavaria, 89.2% of the 18-39-year-old population drive regularly and 2.8% use drugs at least once a week (MiD 2008, ESA 2006, not listed in Table 4). The sample size gets smaller as more selection criteria are applied. Therefore, the values for the Bavarian population could be less reliable. Because there are no data that integrate gender, age and residence as well as drug use, residence and driving, two assumptions had to be adopted.

- Age/gender and residence are independent variables
- Drug prevalence is independent of residence and having a car available

The following example demonstrates the estimation of each stratum's size given an overall target sample size of 200. For the stratum *male*/*18-24*/*<50,000*, the corresponding values (*Age*, *Res*, *Driv*, *Drug*) of Table 4 were multiplied, divided by the sum of the so calculated values of each stratum (sum=0.02098538) and multiplied by 200.

Table 4: Data of the general German population and the general Bavarian population aged 18-39 for estimating the intended sample size.

			Male			Female		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
18-39-year-old[1] (*Age*)	**Germany**		15.4%	11.2%	24.3%	14.8%	10.9%	23.4%
	Bavaria		15.3%	11.2%	23.9%	14.8%	11.2%	23.5%
			Germany			**Bavaria**		
Residence[2] (*Res*)	**< 50,000**		60.3%			74.1%		
	< 500,000		23.8%			11.4%		
	> 500,000		15.9%			14.5%		
			Male			**Female**		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
Regular driving[3] (*Driv*)	**Germany**	**< 50,000**	89,8%	89,8%	94,6%	92,0%	94,9%	96,0%
		< 500,000	75,8%	78,7%	85,5%	73,2%	81,6%	83,6%
		> 500,000	61,6%	56,3%	70,5%	62,4%	51,1%	59,5%
	Bavaria	**< 50,000**	85%	91.9%	96.6%	91.5%	99.2%	98.7%
		< 500,000	85.4%	89.8%	89.3%	83.5%	93.9%	92.9%
		> 500,000	40.3%	47.1%	59.1%	64%	29.5%	59%
			Male			**Female**		
			18-24	**25-29**	**30-39**	**18-24**	**25-29**	**30-39**
Regular drug use[4] (*Drug*)	**Germany**		6.8%	4.2%	2.9%	2.6%	0.8%	1.1%
	Bavaria		5.7%	4.9%	2.6%	3.6%	0%	0.9%

[1, 2] Statistical Yearbook 2009, [3] MiD 2008, [4] ESA 2006

Figure 2 reflects the proportion of males/females, 18-24-/25-29-/30-39-year-olds and persons from city/urban/rural areas in Germany and Bavaria, respectively, that drive a car and use drugs regularly.

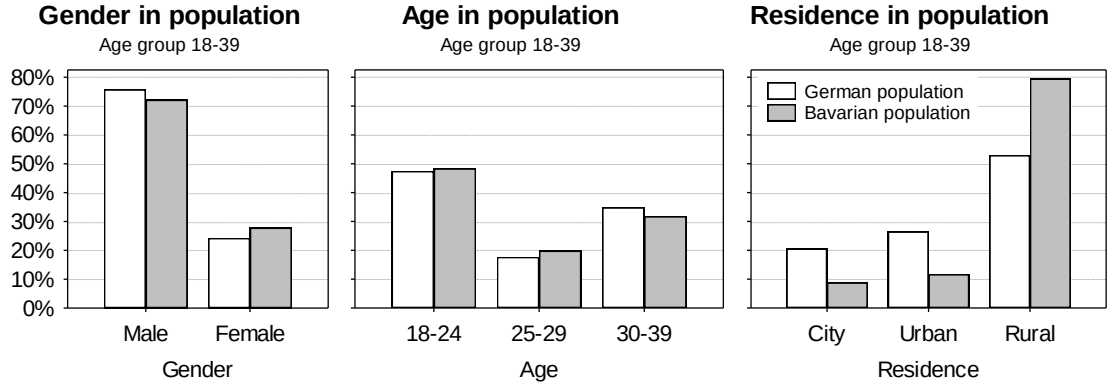


Figure 2: Proportion of males/females, persons from city/urban/rural areas and 18-24-/25-29-/30-39-year-olds in Germany and Bavaria that drive a car and use drugs regularly.

Table 5 shows the intended size of each stratum calculated in the above mentioned manner when applying the percentage values for the general German population.

The control group was planned to reflect the same sample structure. For every second user, it was planned to admit one control.

Table 5: Target sample.

		male			female			
		18-24	25-29	30-39	18-24	25-29	30-39	
Controls	rural area	19	8	14	7	1	4	
	urban area	9	4	7	3	1	2	
	city area	7	3	5	3	1	2	100
Users	rural area	37	15	29	14	3	9	
	urban area	18	8	14	6	2	5	
	city area	14	6	10	5	1	4	200

7.2 Compliance rate

The study design does not allow for a non-responder analysis because nothing is known about the characteristics of users who did not take part in the study. The only experience that could be made refers to persons who contacted the study centre and decided against participating after this first contact. Conspicuously, those persons were often of the 30-39-year-old age group and expressed doubts about data discretion as reason for not taking part. They thought that the participation in the study could conceal adverse consequences regarding their family and job. They were afraid that they would have problems with the police if they took part.

The drop-out rate was very low. Nine subjects (N_{User}=4, $N_{Control}$=5) who were already in the study cancelled the participation or were excluded because of the following reasons:

- Time trouble/bad compliance (3)
- Strong suspicion of false statements (2)
- Smartphone handling/reporting problems (2)
- Licence withdrawal (1)
- Sudden prolonged illness (1)

There was no fail-safe method to find out if subjects were telling the truth regarding their drug consumption and availability of a vehicle. But various precautionary measures were implemented to reduce the possibility of those subjects to take part.

- At the first contact, the subjects had to give a detailed report on their driving und drug using behaviour, habits and circumstances.
- At the first contact, they also had to show the vehicle registration certificate of the vehicle that they drive most frequently.
- Within the study period, they had to deliver a urine sample without previous announcement to prove the drug use that they stated in the daily reports.

Consequently, 19 subjects (all users) were excluded afterwards because they had reported either less than three days with drug consumption or less than seven driving days within the four week study period.

Table 6: Excluded subjects and drop-outs distributed over the stratification variables (N_{User}=23, 10.3%; $N_{Control}$=5, 4.8%).

	male			Female			
	18-24	25-29	30-39	18-24	25-29	30-39	
rural area	3	1	1	0	0	0	
urban area	1	1	1	4	1	1	
city area	8	2	2	1	0	1	28

Table 6 shows the excluded subjects and the drop-outs according to their characteristics concerning gender, age and residence. The greatest part of the excluded subjects was 18-24 years old and from city areas. While conducting the study, it became apparent that subjects from Munich were saliently less reliable. Besides the high number of persons from this area that had to be excluded, an also high number of persons from Munich arranged an appointment but did not appear in the end. In total, it was more difficult to recruit people there. Because of the higher anonymity in bigger cities in general, persons from Munich could not be reached as easily as persons from Wuerzburg and the surrounding areas.

Over the 2-year study period, data of approximately 200 control persons who were not admitted to the study were saved on a waiting list. Controls were only admitted to the study if the intended number within the stratum in question was not higher than approximately one half of the number of users within the same stratum.

Detailed information about persons who applied to participate in the study but did not fulfil the inclusion criteria is not available. In approximately one of five cases, participation had to be refused because the persons used drugs and/or drove too infrequently.

Of the subjects who constitute the final sample size, 39 subjects (13%) provided incomplete datasets (four subjects are included in two of the following categories):

- Four subjects (1.3% of the sample) cancelled the study after approximately two weeks because of personal problems, health problems, a sudden move or time trouble, respectively.
- Six subjects (2%) interrupted the study period because of sudden holidays, an accident, a hospital stay or an injury, respectively.
- 33 subjects (11%) omitted protocols. The number of omitted protocols ranged from one to five and was higher in the user group (15% of users, 3% of controls).
- The subjects were urged to add the corresponding number of omitted protocols in the end, but 20 (6.7%) subjects failed to do so and reported less than 28 days. All in all, 139 days are missing (1.6% of all days).

7.3 Sample size

Table 7 shows the number of subjects and the percentage within each study group for the different strata.

Table 7: Sample size.

		male						female						
		18-24		25-29		30-39		18-24		25-29		30-39		
		n	% N	n	% N	n	% N	n	% N	n	% N	n	% N	
Controls	rural area	12	12%	4	4%	4	4%	8	8%	4	4%	2	2%	100 100%
	urban area	13	13%	4	4%	5	5%	8	8%	5	5%	3	3%	
	city area	10	10%	6	6%	3	3%	4	4%	3	3%	2	2%	
Users	rural area	37	19%	9	5%	7	4%	16	8%	9	5%	4	2%	200 100%
	urban area	24	12%	8	4%	8	4%	17	9%	8	4%	4	2%	
	city area	17	9%	12	6%	3	2%	7	4%	6	3%	4	2%	

Figure 3 shows the proportions of the German/Bavarian population and the study sample for the different levels of the stratifying variables. The sample does not exactly fit the estimated distribution of the general German/Bavarian regularly drug using population that always/sometimes has a car available. More female subjects, 18-29-year-old subjects and subjects from city and urban areas were recruited, whereas male subjects, 30-39-year-old subjects and subjects from rural areas are underrepresented within the sample. Nevertheless, except for the 30-39-year-old population, for all small-sized strata a larger sample size was realised. Thus, the estimates achieved for these small-sized populations are more reliable. The reason for the low number of 30-39-year-old subjects within the sample was already described in Chapter 7.2.

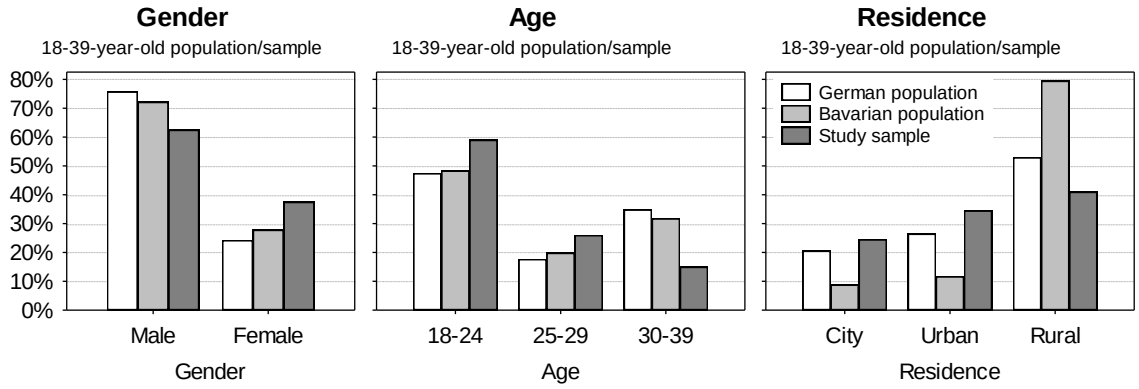


Figure 3: Proportions of the German/Bavarian population/study sample concerning gender, age and residence.

Users and controls were matched with respect to gender, age and residence. Besides, it was tried to match only those subjects who have the same employment status and for whom the same legal alcohol limit applies. In Germany, the zero tolerance applies for persons with a probationary licence and young drivers aged below 21. For all other drivers, the legal BAC amounts to 0.05%. This intention could

not entirely be fulfilled. Three matched pairs included one subject for whom the zero tolerance applied and another one for whom it did not.

Users and controls are fairly equally distributed among the categories of the matching criteria (Table 8). The employment status is also listed in Table 8 to give an impression of the approximate work/leisure ratio within each study group. The conformance between users and controls is of course higher when solely those users are regarded who were assigned to a paired control.

		User	$User_{Matched}$	Control
Gender	**male**	62.5%	61%	
	female	37.5%	39%	
Age	**mean**	24.41	24.85	24.84
	sd	5.29	5.24	5.02
Residence	**rural**	41%	34%	
	urban	34.5%	38%	
	city	24.5%	28%	
Vehicle available	**always**	90.5%	90.9%	98%
	sometimes	9.5%	9.1%	2%
Employment status	**full time employed**	26.5%	35%	35%
	half time employed	9.5%	6%	5%
	minor employed	2.5%	3%	0%
	apprentice	12%	12%	11%
	pupil	17.5%	14%	18%
	student	25.5%	28%	28%
	before job/apprenticeship/university	2%	0%	0%
	unemployed	3%	1%	2%
	housewife/houseman	0%	0%	1%
	retiree/pensioner	0.5%	0%	0%
	civilian service/military service	1%	1%	0%

Table 8: Subjects' characteristics on confounding variables and employment status.

8. Procedure

8.1 Recruitment strategy

To inspire participants with trust, attention was paid to a transparent presentation of the survey in public. A website was created (www.doyoudrugdrive.de / www.dydd.de; Annex 17.1) on which interested persons found information about the intention of the study, the procedure, the costs and benefits and the experiences and opinions of former participants. In addition, a hotline and an email account were setup for the subjects to ask for further details.

In order to be able to reach a population as broad as possible and to meet the demands for representativeness of the sample, participants from rural, urban and city areas were recruited through different methods[19]:

- Financial reward for successful word-of-mouth-recommendation through participants (49.3%) and non-participants (13.7%)
- Flyer distribution at local leisure/work places for young adults (clubs, cafes, bars, cinemas, sports facilities, secondary schools, vocational training schools) (9.7%)
- Articles, interviews and press releases in local newspapers (7.7%)
- Publications on the Internet (5.3%)
- Recruitment within the social environment of the members of the study group (5%)
- Advertisements in city magazines/city guides (4.7%)
- Radio features, radio interviews and radio headline news (3%)
- Recruitment within an existing test driver panel from previous studies (1.7%)

Media relations were very important for promoting the study at the beginning of the recruitment process. But in the end, word-of-mouth recommendation was most effective.

8.2 Time schedule

In the next section, the different study events are summarised in bullet points stating the location and the modality of each event, respectively, followed by a detailed description of the procedure.

Figure 4 depicts the study procedure schematically. Broken lines within the illustration point to study events that were not definitely timed.

[19] The numbers in brackets refer to the percentage of subjects recruited by each strategy.

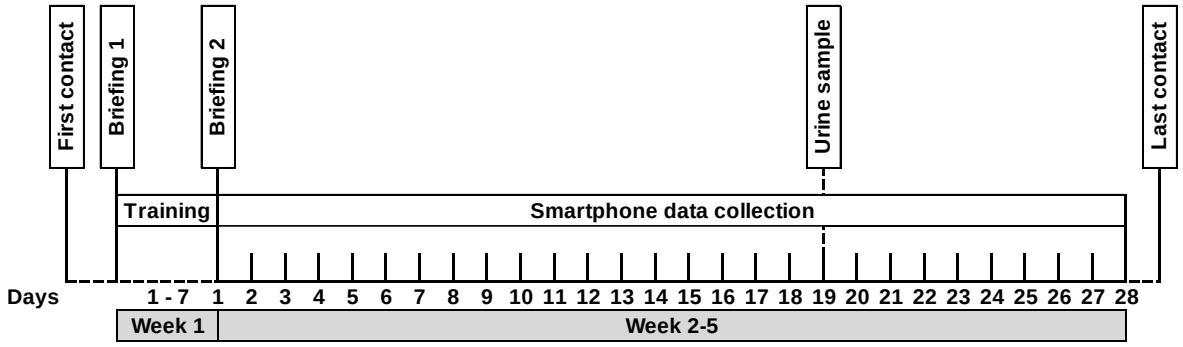


Figure 4 Study timeline.

First contact (by telephone/email/face-to-face):

- subject screening
- time scheduling

The subjects contacted the investigators via telephone, email or visited the study centre directly. At this first contact, the subjects were screened for their driving and drug consuming behaviour and shortly briefed on the study. If the inclusion criteria were fulfilled and the person decided to take part, two appointments were arranged at the study centre at intervals of several days. For persons who wanted to enrol for the control group, the matching criteria were screened and saved on a waiting list. They were only admitted to the study if their values on the confounding variables were similar to those of a subject in the user group. All subjects were instructed to show their driver licence and vehicle registration certificate at the first briefing to make sure that they have a car available and drive regularly.

Briefing 1 (at study centre):

- information
- informed consent
- agreement on data request at the Central Register of Traffic Offenders
- smartphone handling
- daily questionnaire structure
- questionnaire on driving and drug experience

The first briefing at the study centre included a detailed description of the study procedure. The subjects had to sign that they were voluntarily participating in the study, that they were comprehensively informed and that they were given a smartphone in exchange for a deposit of either 150 euros or a copy of their identity card. The deposit was safely stored at the study centre for the duration of the study and was returned to the subjects at the last contact. To be able to query the registered traffic offences at the Central Register of Traffic Offenders, the subjects had to sign a written authorisation and name their full name and address. A large part of this first briefing was intended to explain the handling of the smartphone and the structure of the daily questionnaire that was implemented on it. At the end of this

meeting, the subjects filled in a paper and pencil questionnaire about previous experiences concerning driving, drug use and drug driving, corresponding attitudes and relevant sociodemographic and social context characteristics (Q-Start; Annex 17.2).

Smartphone training (at home):

- probationary protocols
- questionnaire about personality

Between the first and the second briefing, the subjects were required to fill in two probationary protocols and another paper and pencil questionnaire that contained eight personality questionnaires (Q-Pers; Chapter 10.3, Annex 17.3). The relevance of the personality questionnaires for drug driving was derived from a literature review that was conducted prior to the study.

Briefing 2 (at study centre):

- protocol review
- training of critical recording rules
- SCID interview

The purpose of the second briefing at the study centre was to review the probationary protocols and discuss any associated difficulties. In order to illustrate critical and difficult instructions on how to structure the daily routine, the subjects had to process corresponding exercises. The main part of the session was used for carrying out the SCID-I (Structured Clinical Interview on DSM-IV Axis I Disorders, Wittchen et al., 1997). Major mental disorders and the psychiatric history of each subject were queried with the focus on alcohol and/or drug dependence and abuse.

Smartphone data collection (at home): inquiry by telephone in the case of...

- data inconsistency
- recording problems
- dangerous traffic occurrences

For each of the following 28 consecutive days, the subjects had to fill in the questionnaire on the smartphone by specifying their daily routine with the focus on drug consumption and driving. It was possible to save the answered part of the questionnaire on the smartphone. So, the subjects were able to fill in the questionnaire at several times a day whenever they had the time to do so. They could autonomously determine the time and the locality for processing the questionnaire on condition that they sent the record of a day at the latest two days later. In order to provide an incentive to fulfil the task in due time, a reward system was compiled based on the time delay between the recorded day and the day on which the questionnaire was sent (Chapter 11.3). The intention was to receive 28 records per person. Each record should represent a regular day within the subject's usual environment. If the normal daily routine was disordered for more than three

days because of a medical condition, a domestic or an international journey, the subjects were asked to extend the study period at the end by the same number of days. The recordings were promptly checked for data inconsistencies after they were received at the study centre. If any inconsistencies became apparent, the subjects were called by telephone to discuss the recordings in question. Another reason for calling the subjects was given when a dangerous traffic situation was recorded. In this case, the subjects were asked about the circumstances and about subjective causes. Of course, the subjects always had the possibility to call the study centre in the case of problems or questions related to the study.

Urine sample (at study centre):

- urine sample
- ART2020
- toxicological analysis at Institute of Legal Medicine Wuerzburg/Munich

The subjects were informed that they would have to deliver a urine sample to prove their drug use and in the case of the controls to monitor their drug abstinence. In Wuerzburg, this appointment was also used to assess the traffic-relevant performance of the participants by a series of seven subtests of the Act & React Test System (ART) 2020 Standard test battery (Chapter 10.5), developed by the Austrian Road Safety Board (ARSB). Within the 4-week study period, the subjects were called spontaneously to come to the study centre to perform the ART 2020 test battery. It was not mentioned that the urine sample would also be collected at this occasion. So, it was possible to collect it without previous announcement. In Munich, the ART2020 test was not conducted for logistical reasons. To guarantee that the urine test could not be anticipated by the participants, they were asked to come to the study centre within 24 hours after an unexpected phone call. If the appointment could not take place within the intended timeframe, the subjects were told that they would get called again another time. This was repeated until the attempt to arrange a spontaneous appointment was successful. The urine samples were analysed by the Institute of Legal Medicine in Wuerzburg and Munich, respectively. Detailed information about the agreement between the test results and the previous drug use behaviour that was reported in the daily questionnaire is given in Chapter 12.3.

Last contact (at study centre):

- payment
- evaluation
- advisory service recommendation if indicated

After the subjects completed the recording period, the last contact was arranged to pay out the credits and to collect the smartphone. Moreover, an interview was conducted (Q-End). The subjects had the opportunity to evaluate the study and were asked about their knowledge about legislation and sanctions concerning drug driving, about their academic and occupational background and about their relationship to their parents. They were also asked to voluntarily add a guestbook comment on the study website that should encourage other potential subjects to take part. In the case

that a risky consumption pattern was observed, the person concerned was urged to consult a drug advisory service. A list with all relevant contact details of drug advisory services in their vicinity was delivered to all subjects.

9. Technical aspects of data collection

9.1 System overview

The data collection system for the daily questionnaires was implemented by using the following components (Figure 5):

- RIM BlackBerry 7290 (50 pieces) on which the subjects filled in the daily questionnaire
- Wireless network (GPRS data service by Vodafone Germany)
- Mobile Data Services (MDS) by the BlackBerry vendor RIM (Research in Motion) for the encrypted data transport
- Dedicated server (PC with 2x Intel Xeon 3.2 GHz processor, 2 GB RAM, Microsoft Windows Server 2003 operating system, MySQL 5.0 data base) for the data processing and storage
- OpenVPN virtual private network for encrypted transport to the workstations
- Workstations with data analysis software (Statistica 8) and data control software (Microsoft Access 2007)

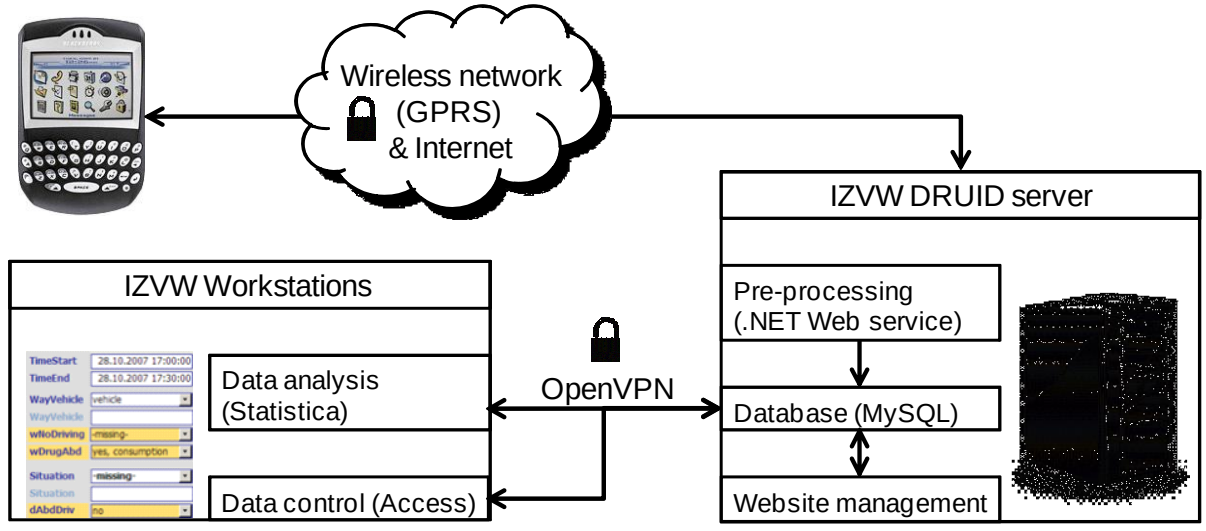


Figure 5: System overview.

9.2 Questionnaire application on BlackBerry devices

The questionnaire application on the smartphones was achieved by writing an application programme using the BlackBerry graphical user interface and network access. Thus, the application can be directly operated by the respondent using the smartphone's controls (scroll wheel, confirm and cancel buttons, QWERTY keyboard)

and all data can be sent in encrypted form through the RIM Mobile Data Services over the wireless connection for immediate further processing.

The data entry was simplified by providing response options. In most cases only one alternative could be selected. Only few questions allowed multiple choices (e.g. mode of transport, kind of drug consumed). For some questions a “miscellaneous” response was listed. If the experience of the respondent could not be expressed by the predetermined responses, the subject selected this field and a text field appeared to describe the answer in own words. The application reflected a hierarchical structure of a course of a day (Chapter 10.1.1). The questionnaire structure was adaptive to allow for the reproduction of individually different daily activities by marking out questions that are not relevant for current entries. Conflicting data entries were reported immediately and had to be corrected before sending the questionnaire. A full description of the consistencies that were checked by the programme is presented in Chapter 11.4.1.

9.3 Wireless data transmission

The BlackBerry vendor RIM operates a world-wide network (Mobile Data Services, MDS) for secure business communication. The BlackBerry device connects to a server operated by RIM in its local wireless network via GPRS, which then routes the data over the Internet to the customer’s (in this case: to the IZVW study centre) BlackBerry Enterprise Server (BES). All data is encrypted on the mobile device (by using the Advanced Encryption Standard, AES) and only decrypted on the BES server. Every BlackBerry device has an ID called BlackBerry PIN, which is used to identify the device to the BES.

9.4 Database server

At the study centre (IZVW), a dedicated server was set up for the reception and storage of the questionnaire data. The server is used as a Blackberry Enterprise Server (BES) and is thus connected to the MDS network. Additionally, the Microsoft Internet Information Server (IIS) has been installed to host Active Server Pages. NET (ASP.NET) 2.0 web services and the MySQL 5.0 database server for data storage. For pre-processing, an ASP.NET web service receives the questionnaires sent by the BlackBerry devices (which are transmitted in a XML/SOAP based format) and inserts the contained data into the database by using relational database (SQL) queries. The data can then be accessed from workstations of the IZVW researchers who are working on the project. When it is sent over the university network, data is encrypted by using a VPN tunnel (OpenVPN 2.0.9). Daily backups of the database are performed and archived on external hard-disks.

9.5 Data access and subject management

During each subject's study period, additional tasks had to be performed (e.g. assignment of a smartphone to the subject, entering basic subject information in the database, sending messages to the smartphone, etc.). These tasks were performed from the IZVW workstations by using Web applications (implemented in ASP.NET 2.0) that were running on the database server. The applications perform SQL queries on the database or execute relevant BlackBerry helper programmes.

Not all possible data inconsistencies were detectable by the system. In Chapter 11.4.2 data inconsistencies are listed that were only traceable through a detailed examination of the whole context of a particular report. All data were checked for consistencies by IZVW study assistants. For this purpose, a control form was designed in Microsoft Access, which operates the data storage on the server using SQL queries (Figure 6).

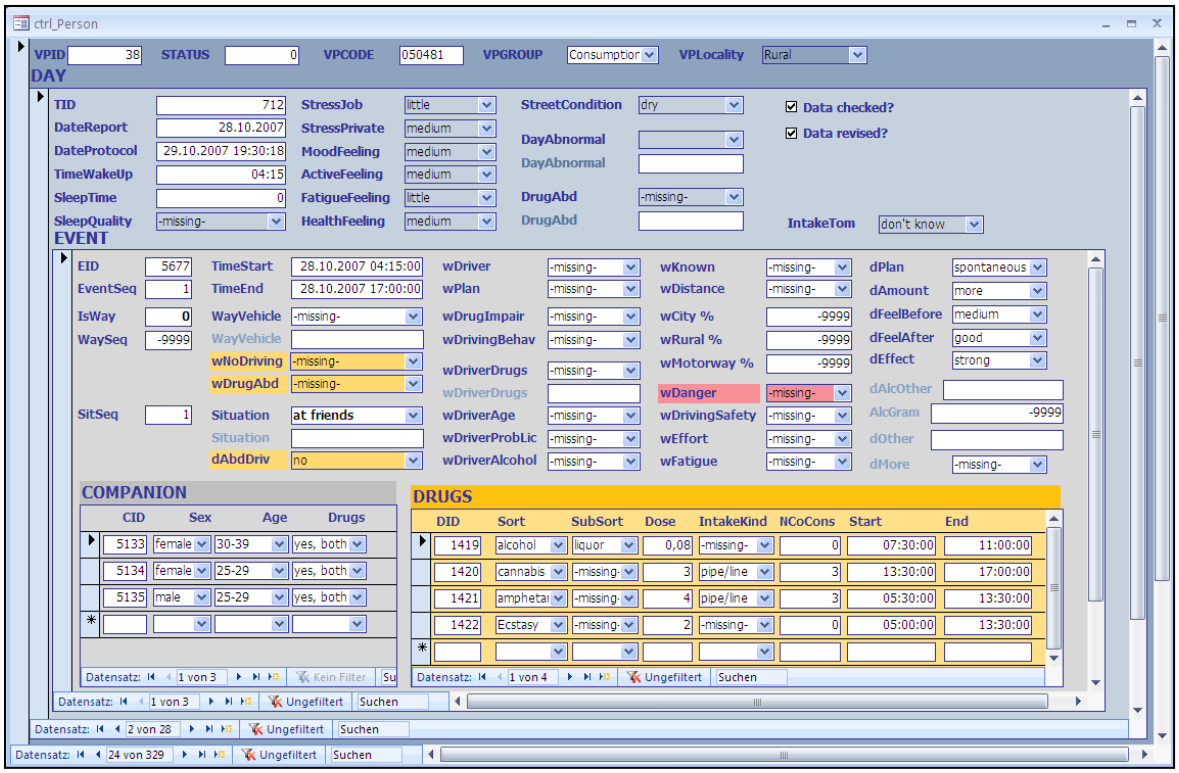


Figure 6: Microsoft Access form for person-controlled data consistency check.

9.6 Performance reliability of the system

The technical setup was very reliable. The database server's internet connection (and thus the connection to the BlackBerry devices) was rarely lost. The server's main board broke once during the study. A copy of the server's hard disk (which was undamaged) was created and the system was migrated to a similar PC. No data was lost.

10.Data pools

10.1 Smartphone data collection

10.1.1 Questionnaire structure

Each subject was logged in the database with an individual ID, subject code and the respective parameter values concerning study group and residence. All other person variables were gathered via paper and pencil questionnaires and are described in Chapter 10.2.

The daily questionnaire contained three different levels (an overview will be given in Chapter 10.1.3). General questions concerning the circumstances of the whole day (Level 1) were placed in the beginning and in the end of the questionnaire. The main task when producing the daily report was the listing of all daily episodes in chronological order with alternating situations (locations or activities) and intermediate trips (Level 2) (Figure 7).

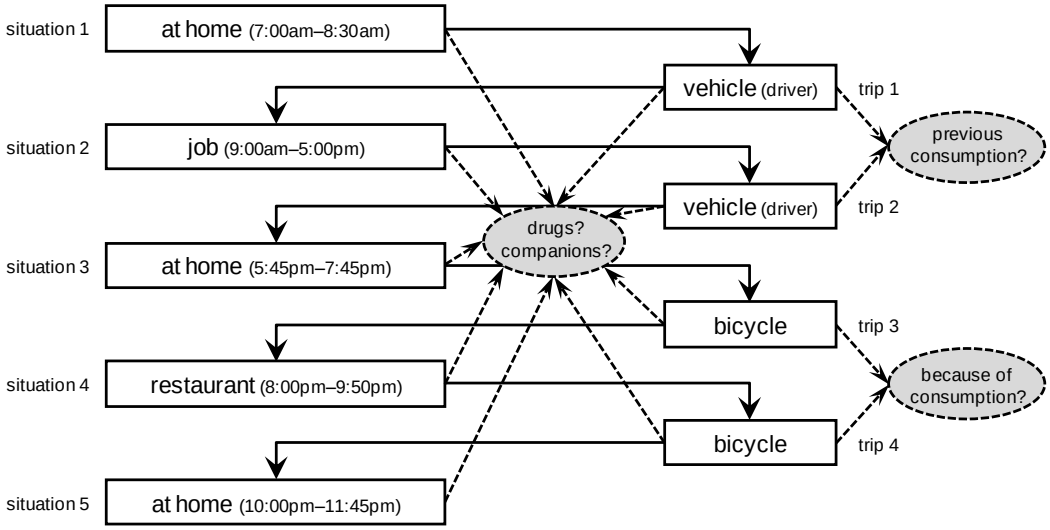


Figure 7: Illustration of an exemplary listing of a fictitious day.

The number of episodes per day depended on the actual daily structure. Each episode had to be described in its main characteristics (i.e. location and time for each situation, or mode of transport, distance, etc. for each trip). Two questions were asked for both situations and trips. The subjects had to indicate for each episode if they consumed drugs[20] (Level 3a) and if they had companions (Level 3b). If so, the main characteristics of these occurrences were inquired (i.e. amount, time of

[20] In the present paper, the term “drug” comprises illicit drugs and alcohol.

consumption for each drug; age, gender, consumption behaviour for each companion).

10.1.2 Drug use and driving interaction

Through the linkage between data about drug consumption and traffic participation and through the additional daily information, drug driving incidences could be detected and described with respect to their situational circumstances. Furthermore, circumstances that promote decisions against drug driving or towards risk limitation, i.e. the mutual interference of drug use and driving, are of special interest.

To find out if someone separates drug consumption and driving, the following behavioural intentions were surveyed: If the subjects stated **drug use before driving a vehicle**, they had to indicate if they **reduced the amount of drugs** due to driving. If the subjects stated **no drug use before driving a vehicle**, they were asked if they **abandoned drug use** due to driving or if they did not use drugs because of other reasons. If the subjects stated that **they were not driving a vehicle**, they were asked if this was due to **previous** or **subsequent drug consumption** or because of other reasons. This query was realised through the following questions:

Question *Did you take drugs before or during this trip?* (if trip was travelled **as driver** of a vehicle).

Response options:
- yes, I **consumed drugs** beforehand without restricting it,
- no, I **abandoned drug consumption** due to driving,
- yes, but I **restricted drug consumption** due to driving,
- no, I didn't use drugs due to **other causes**.

In the case of abandonment (2) or reduction (3), the subjects had to **specify the episode in which they abandoned/restricted drug consumption**.

Question *Why didn't you travel as a driver of a vehicle?* (if trip was **not travelled as a driver** of a vehicle).

Response options:
- because of **previous drug consumption**,
- because of **subsequent drug consumption**,
- because of **other reasons**.

10.1.3 Variables and adaptive layout

In Table 9, all information that was gathered by the daily questionnaire is listed for each data level. The exact wording of the questions and response options of the daily questionnaire can be seen in the Annex (Annex 17.3). Adaptive questions are labelled as optional. The exact adaptive order of the questions in the questionnaire is diagrammed in Figure 8 on the next page.

Table 9: Content of the daily questionnaire.

LEVEL 1: DAY	
	- Date - Time wake up/bedtime - Length of sleeping time - Sleeping quality - Abnormalities in daily routine - Stress level (private and job-related) - Mood - Activity level - Fatigue - Health state - Street condition - Reason for drug abstinence – same day (optional) - Intention to consume drugs – next day
LEVEL 2: EPISODE	
Situation:	- Location/activity - Time start - Time end - Abandoned/restricted drug use in this situation (optional)
Trip	- Time start - Time end - Mode of transport - Planned or spontaneous trip - Distance - Abstain from driving because of previous/subsequent consumption or other reason (optional) - Abandoned/restricted drug use on this trip (optional)
Driving details (optional)	- Driver/passenger - Percentage of motorway/rural/urban road - Abandoned/restricted drug use because of driving (optional) - Familiar road - Dangerous situation - Driving safety (optional) - Driving effort (optional) - Driving fatigue (optional)
Drug driving details (optional)	- Impairment - Changed driving behaviour
LEVEL 3a: DRUGS (optional)	
	- Kind of drug - Intake kind - Dose - Number co-consumer - Time of consumption - Planned amount of drug - Planned or spontaneous consumption - Drug effect - Feeling before and after consumption
LEVEL 3b: COMPANIONS (optional)	
	- Age - Gender - Current drug consumption

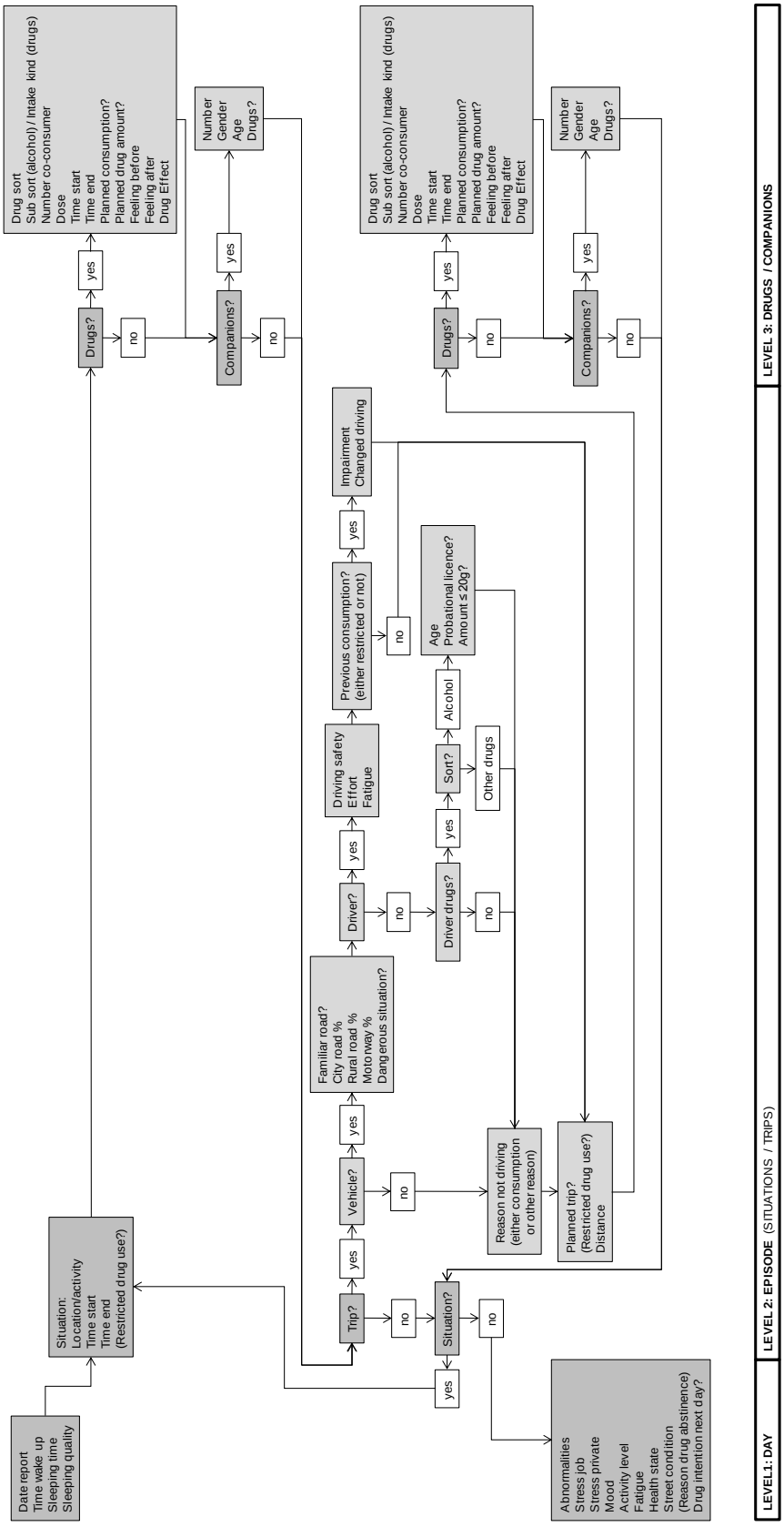
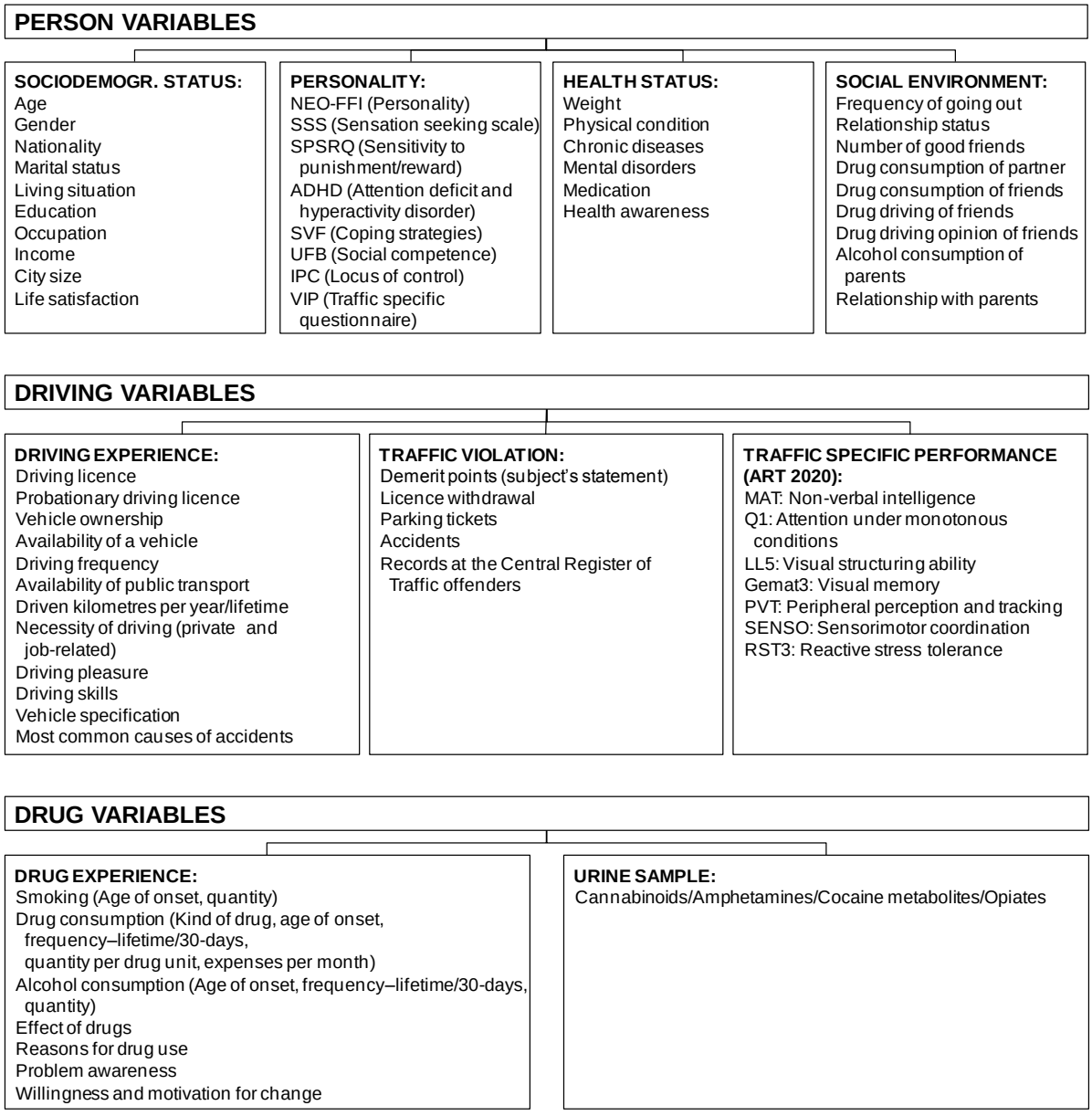


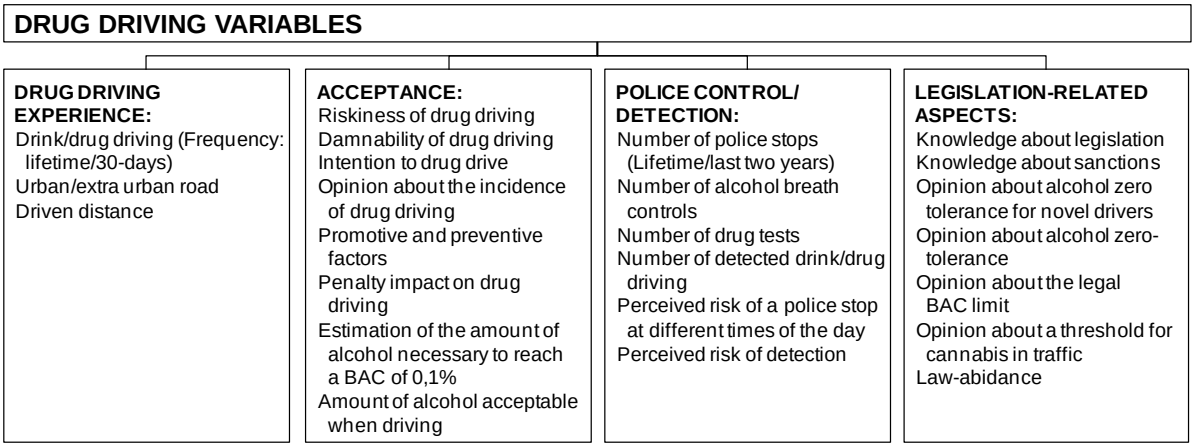
Figure 8: Variables and dependencies between the variables of the daily questionnaire.

10.2 Overview of person-related data

Included in the study was also an extended diagnostic part to assess relevant sociodemographic information, relevant previous experiences, personality variables and attitudes. As described in Chapter 8.2, this information was gathered through paper and pencil questionnaires. Moreover, the SCID-I was conducted and a urine sample was collected. Additionally, the traffic-specific performance was tested with the ART2020 test battery and the subjects' records that are saved at the Central Register of Traffic Offenders were requested. All person-related information is summarised in Figure 9 in thematic order.

Figure 9: Person-related data.





10.3 Personality questionnaires

Based on the literature review that was described in Chapter 5.2, it was decided to apply the following series of eight personality questionnaires:

- **IPC** – Control beliefs (Krampen, 1981): 'Internal control orientation', 'Powerful others control orientation', 'Chance control orientation'
- **SSS** – Sensation-Seeking (Beauducel, Strobel, & Brocke, 2003)[21]: 'Thrill and Adventure Seeking', 'Disinhibition', 'Experience Seeking', 'Boredom Susceptibility'
- **ADHDQ** – Attention Deficit and Hyperactivity Disorder in childhood (Zeberlein & Küfner, 2003): 'Distractibility', 'Inattention', 'Hyperactivity/Impulsivity', 'Psycho-social consequences', 'Drug effect on inattention and hyperactivity'
- **SPSRQ** – Sensitivity to punishment and Sensitivity to reward (Torrubia, Ávila, Moltó, & Caseras, 2001): 'Sensitivity to Punishment', 'Sensitivity to Reward'
- **UFB** – Social competence (Ullrich & Ullrich, 1998): 'Fear of blame and criticism', 'Fear of contact to those of the opposite sex, fear of responsibility', 'Inability to set plans and set plans into motion' (originally positive scale), 'Inability to say no', 'Feeling of self-blame in relation to their own actions as they relate to and affect others', 'Inappropriately exaggerated feelings of embarrassment'
- **SVF** – Stress-coping strategies (Erdmann & Janke, 2008): 'Compare with others', 'Guilt defence', 'Distraction from situation', 'Substitutional satisfaction', 'Situational control', 'Reaction control', 'Positive self-instruction', 'Need for social support', 'Avoidance', 'Flight tendency', 'Rumination', 'Resignation', 'Self-accusation', 'Self-medication/alcohol use'
- **VIP** – Traffic-specific item pool (Schmidt & Piringer, 1986)[22]: 'Orientation at social expectations', 'Uncritical self-perception', 'Aggressive interaction', 'Emotional relationship to car and driving'
- **NEO-FFI** – Personality (Borkenau & Ostendorf, 1993)[23]: 'Neuroticism', 'Extraversion', 'Openness to experience', 'Agreeableness', 'Conscientiousness'.

[21] According to Zuckerman, 1978.
[22] As a measurement of traffic-specific personality dimensions.
[23] As a measurement of broader personality dimensions; according to Costa & McCrae, 1995.

10.4 Structured Clinical Interview for DSM Disorders (SCID)

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) by Wittchen et al. (1997) was chosen to be administered in the present study to determine DSM-IV Axis I Disorders (major mental disorders) – especially alcohol/drug-use disorders. The DSM-IV is the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (APA, 1994).

The 300 interviews were conducted by two research assistants, who had had experience with clinical populations and had been trained to conduct the SCID-I.

The following disorders were queried:

- **Dependence/Abuse**: Alcohol, other substances
- **Mood Disorders**: Major Depressive Disorder, Mania, Dysthymic Disorder, Hypomania, Bipolar Disorders
- **Anxiety Disorders**: Panic Disorder, Agoraphobia, Social Phobia, Specific Phobia, Obsessive-Compulsive Disorder, General Anxiety Disorder, Post Traumatic Stress Disorder
- **Eating Disorders**: Bulimia, Anorexia
- **Psychotic Disorders**: Schizophrenia, Schizophreniform Disorder, Schizoaffective Disorder, Delusional Disorder, Brief Psychotic Disorder
- Any **Somatoform Disorder**
- **Adjustment Disorder**

Besides, it was inquired if the subjects have ever been in outpatient or inpatient treatment or if any diagnoses were made in the past concerning major mental disorders (including AD(H)D and Borderline Personality Disorder).

According to DSM-IV, Substance Dependence is defined as a maladaptive pattern of substance use leading to clinically significant impairment or distress, as manifested by three (or more) of the following criteria, occurring any time in the same 12-month period (APA, 1994):

- The substance is often taken in larger amounts or over a longer period than intended (*Loss of control*).
- There is a persistent desire or unsuccessful effort to cut down or control substance use (*Desire to change*)
- A great deal of time is spent in activities necessary to obtain the substance, use the substance, or recover from its effects (*Time costs*).
- Important social, occupational, or recreational activities are given up or reduced because of substance use (*Neglect of other activities*).
- The substance use is continued despite knowledge of having a persistent physical or psychological problem that is likely to have been caused or exacerbated by the substance (e.g. current cocaine use despite recognition of cocaine-induced depression or continued drinking despite recognition that an ulcer was made worse by alcohol consumption) (*Consumption despite health problems*).

- Tolerance, as defined by either of the following: (a) A need for markedly increased amounts of the substance to achieve intoxication or the desired effect or (b) Markedly diminished effect with continued use of the same amount of the substance (*Tolerance*).
- Withdrawal, as manifested by either of the following: (a) The characteristic withdrawal syndrome for the substance or (b) The same (or closely related) substance is taken to relieve or avoid withdrawal symptoms (*Withdrawal*).

According to DSM-IV, Substance Abuse is defined as a maladaptive pattern of substance use leading to clinically significant impairment or distress as manifested by one (or more) of the following criteria, occurring within a 12-month period (APA, 1994):

- Recurrent substance use resulting in a failure to fulfil major role obligations at work, school, or home (such as repeated absences or poor work performance related to substance use; substance-related absences, suspensions, or expulsions from school; or neglect of children or household) (*Neglect of duties*).
- Recurrent substance use in situations in which it is physically hazardous (such as driving an automobile or operating a machine when impaired by substance use) (*Endangerment*).
- Recurrent substance-related legal problems (such as arrests for substance related disorderly conduct) (*Legal problems*).
- Continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance (e.g. arguments with spouse about consequences of intoxication and physical fights) (*Consumption despite social problems)*.

The actual consumed amount of the substance is not relevant for diagnosing Substance Abuse or Dependence according to DSM-IV. The focus lies on the clinically significant impairment or distress caused by the substance use.

The interview took between ½ hour and 2 hours depending on the complexity of the past psychiatric history and the subject's ability to clearly describe episodes of current and past symptoms.

10.5 Traffic-specific performance tests (ART2020)

To test the psychometric performance in accord with the German Driver’s Licence Ordinance ("Fahrerlaubnis-Verordnung", FeV) Annex 5 (Janker, 2009) and the Guidelines for Expertise on Driver Aptitude Chapter 2.5 ("Begutachtungs-Leitlinien zur Kraftfahrereignung”; Lewrenz, 2000), the applied test procedure has to fulfil several requirements:

- The applied test procedures have to be standardised, objective and scientifically validated.

- In order to assess the traffic-specific performance, the following cognitive measures that are closely associated with driving abilities have to be assessed: Coordination, concentration, attention, reaction capacity and stress resistance.

The computer-based Act & React Test System (ART) 2020 Standard test battery, developed by the Austrian Road Safety Board (ARSB), fulfils these requirements. It has been designed to assess cognitive measures closely associated with driving abilities and is certified for this purpose in Germany and Austria.

A series of seven ART2020 tests was applied:

- **MAT** (Non-verbal intelligence test; Bukasa & Wenninger, 2001a): The test is a screening of logical reasoning, understanding of rules and causal relations.
- **Q1** (Test for attention under monotonous conditions; Bukasa & Wenninger, 2001b): This test measures continuity of attention regarding quantitative and qualitative aspects.
- **LL5** (Test for visual structuring ability; Bukasa & Wenninger, 2001c): The test examines dynamic perception functions in a complex visual environment under time pressure.
- **GEMAT3** (Visual memory test; Bukasa & Wenninger, 2001d): The test examines non-verbal short term recall functions.
- **PVT** (Test for sensorimotor coordination and peripheral perception ability; Bukasa, Piringer, & Wenninger, 2004): The test examines eye-hand-foot coordination and peripheral perception in a dual task condition
- **SENSO** (Test for sensorimotor coordination; Bukasa, Piringer, & Wenninger, 2003): The test records traffic-specific eye-hand-foot coordination under free choice and pre-given speed.
- **RST3** (Test for reactive stress tolerance; Bukasa & Wenninger, 2001e): The test measures resistance to work load determined by different speed levels and information processing complexity.

The applied tests can be assigned to the performance dimensions listed in the FeV (Table 10):

Table 10: Applied ART2020 tests and associated performance dimensions.

ART2020 tests and associated performance dimensions
Coordination capacity: LL5, PVT, SENSO
Concentration and attention capacity: Q1
Reaction capacity: RST3
Stress resistance: RST3

The GEMAT3 and the MAT measure memory capacities and intelligence, respectively. These dimensions are not listed in the FeV. However, in Austria these tests are applied as standard test procedures. In the framework of the present study, they are relevant to detect potential cognitive deficits of long term drug users.

10.6 Data integration

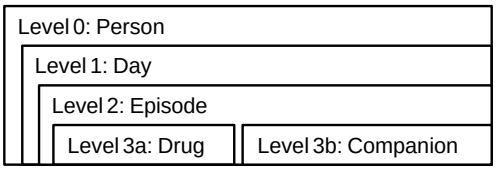


Figure 10: Data levels.

The smartphone data collection provided data of three different data levels (Figure 10): Day, Episode (i.e. situation or trip) and Drugs/Companions. Through the additional inquiry of relevant data about the subjects' socio-demographic background, previous experiences concerning driving, drug consumption, road traffic offences, corresponding attitudes, personality traits and driving performance, a fourth level was implemented that refers to personal data.

Levels 1 to 3 specify the **situational characteristics of drug driving** (e.g. weekday, daytime, route, distance, companions, etc.). Besides, a prediction can be made regarding the **extent to which drug driving occurs**. All personal data (Level 0) specify the **characteristics of drug driving individuals**. From all this information, rehabilitation and prevention strategies for targeting those most at risk can be deduced.

11. Additional requirements

11.1 Ethical approval and data privacy

The study did not require approval from the medical ethics committee. This was affirmed by the responsible committee of the medical faculty at the University of Wuerzburg with the argument that the study was designed as an epidemiological study in which drug use and driving were observed but no drugs administered.

One very important issue was the protection of data privacy. In this context, the following provisions were arranged and maintained:

- Consultation of the data protection agency at the University of Wuerzburg: The data protection agency was consulted on all judicial questions concerning data privacy and the legal protection of the participating subjects.
- Professional discretion: All persons working in the project were bound to observe professional secrecy. They were not allowed to give information about personal data of the participating subjects to third parties.
- Support from the public prosecution in charge: The public prosecution in charge guaranteed that the data of the subjects would neither be inspected during the study participation nor after unless a participating subject was suspected of having committed a notifiable, serious offence that requires disclosure.
- Anonymous data recording: Each subject was equipped with an anonymous code that was used for data storage and analysis. As far as personal or individual data were collected, they were kept strictly confidential so they could not be matched to any individual. After termination of the project, all individual data were destroyed.

The voluntary participation of the subjects was ensured by an informed consent that was signed by each subject before starting the survey. Therein, they declared to be elaborately informed about the study and to participate voluntarily.

11.2 Instructions / Training

The briefing sessions included a one-to-one instruction on how to structure the daily routine. The investigator guided the subject through the questionnaire by reporting a predefined day. This exemplary day contained all situations that are relevant to process exhaustively the possible branches of the questionnaire. Additionally, help texts were placed next to crucial questions in the questionnaire. If the respondent felt unsure about answering a question, the help text provided information about its meaning.

The subjects were instructed to list all daily episodes in chronological order with alternating situations and intermediate trips. It was emphasised that episodes with

drug consumption and driving should be focused when compiling the report. Individual drug use and driving should be reported as accurately as possible. Before including someone in the study, it was clarified whether the person had planned any travels lasting more than three days. If so, the study participation was postponed to the time after the absence. In doing so, it was assured that most reports refer to the residence the person was chosen for. Trips for up to three days did not lead to a postponement. If a subject spontaneously went on vacation while participating, the reporting was only interrupted for the time of the journey if reporting was impossible while travelling. In these cases, the subjects added the number of such days to the end of the study. Hence, reports of at least 28 regular days were received in total. The same procedure was applied for days of illness.

Day-related instruction

A report runs from wake up to bedtime and is not defined by date. For instance, the report covers a 26 hour period of time if the subject gets up at 5am and goes to bed at 7am the next day.

However, two reports should be provided in the case that someone has an all-night party and completely skips one sleeping period. The break should be placed at a reasonable point in time, e.g. when the subject leaves one location. In this case, the first day would end with a trip (from one location to another) and the second day would start at the other location by stating zero sleeping time.

The sleeping time should reflect the actual hours of sleep. Thus, it is quite possible that the reported sleeping time differs from the time span between reported bedtime and getting up the next day, e.g. when the sleep quality was bad and the person was awake all night long.

When a person is travelling and is staying a night over, the day has to be marked as abnormal (namely as domestic or international journey).

Situation-related instruction

Not all subsequent situations need to be separated by a trip. A new situation might start without a change of location. For example, when a subject is working at home, the situation *job* follows the situation *at home* without an intermediate trip. Likewise, one situation becomes two contiguous situations at the same location when the number of companions changes (e.g. receiving a visit in the evening and being alone at home the rest of the day). Not every change of the number of companions at the same location has to be recorded as a separate situation. The respondents were instructed to record prominent situational changes, e.g. alone at home until 6pm (situation 1) and with friends at home afterwards (situation 2) without listing the arrival of each friend separately (Figure 11).

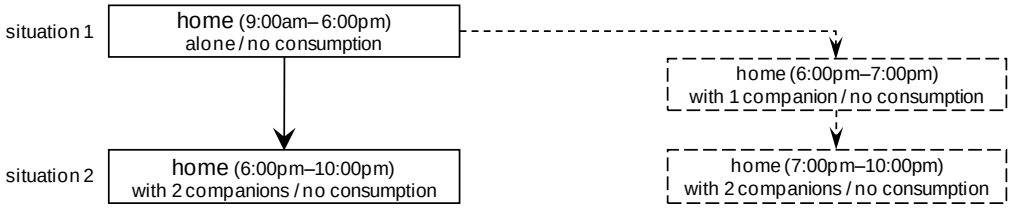


Figure 11: Example for situations that can be conflated.

However, situations containing drug consumption had to be described as accurately as possible in view of location, time and number of companions in the situation, e.g. alone at home until 6pm (situation 1), afterwards with parents at home until 8pm (situation 2), followed by a situation with friends in which cannabis was consumed (situation 3) (Figure 12).

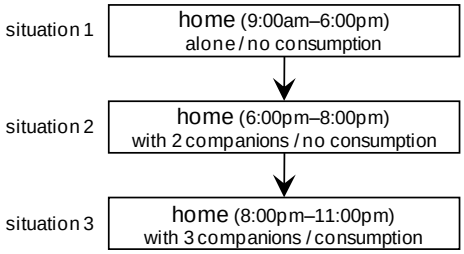


Figure 12: Example for situations that cannot be conflated.

If someone took a nap of more than one hour during daytime, this is listed as a separate situation using the response option *other*.

Trip-related instruction

A trip is defined as every distance covered on foot or by another mode of transport outside home that separates two contiguous situations. A break within the trip is not listed as a separate situation if the break constitutes a short errand and the errand is not the target destination (Figure 13).

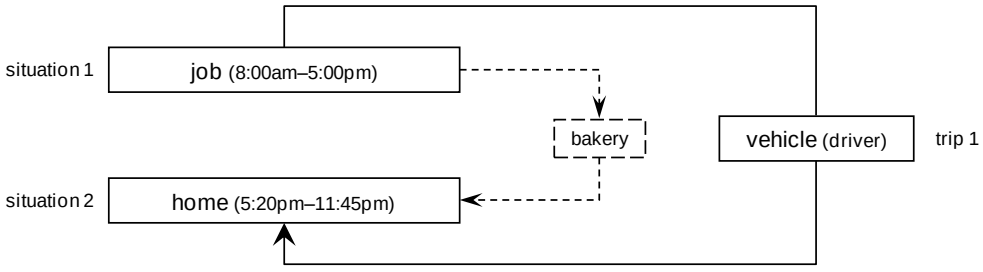


Figure 13: Example for waypoints that do not have to be listed.

As a rule, it was determined that situations that last no longer than 15 minutes do not have to be listed unless drugs were consumed therein. The ratio between the duration of the trip and the distance should remain plausible depending on the mode of transport that is stated for the trip.

Furthermore, a situation can be skipped when it only serves for changing the mode of transport. If, for example, someone travels from one location to another by walking, tram or train, this trip is cited as one trip covered by different modes of transport (Figure 14). Again, this rule is suspended if someone takes drugs at one waypoint. Apart from this, an intermediate stop has to be mentioned if one changes from driver to passenger of a vehicle. When stating a trip taken by a vehicle, the respondent can only specify if he/she is travelling it either as a driver or as passenger and not both. By inserting an intermediate situation, the trips can be regarded separately from one another.

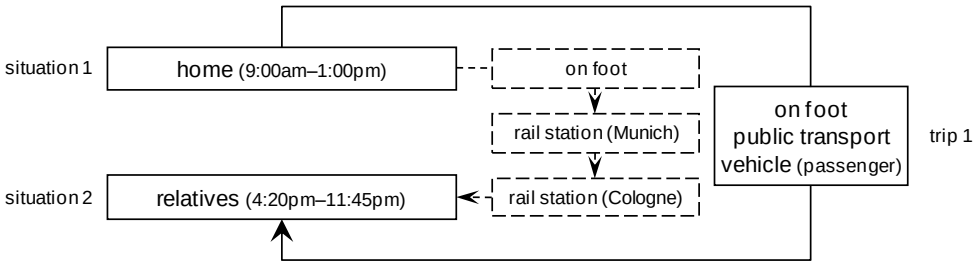


Figure 14: Example for trips that can be conflated.

If a trip is covered by different modes of transport and one of them is driving a car, the information about the distance refers to the car drive only.

The subjects had to state if a trip is planned or spontaneous. This question does not refer to the mode of transport or route, but to the destination. A trip is spontaneous if someone decides about it in the situation immediately before the trip. Planned trips are periodical trips, e.g. the weekly trip to a sport facility or the daily trip to work/school. The way back home in the evening is generally planned unless the person planned to stay overnight and spontaneously changes this plan.

If the respondent has to give reasons for not driving a car, he/she can only state previous or subsequent drug consumption if a car is actually available. If a person rides the bicycle when going out because of a planned consumption afterwards, he/she can state drug consumption as a reason for not driving only for the way there but not for the way back. On the way back, the person has no car available (Figure 15).

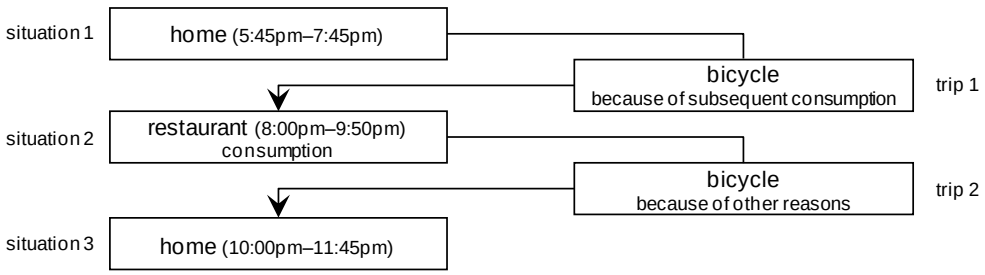


Figure 15: Example for trips for which consumption can be specified as reason for not driving.

If a person travels a trip as driver of a vehicle and had consumed drugs beforehand, he/she has to state the previous drug consumption when it took place immediately before the trip. If the consumption dates back some time, the person has to state it only if he/she thinks that the drug consumption still has an effect on driving, i.e. when the person is still noticing an effect (Figure 16).

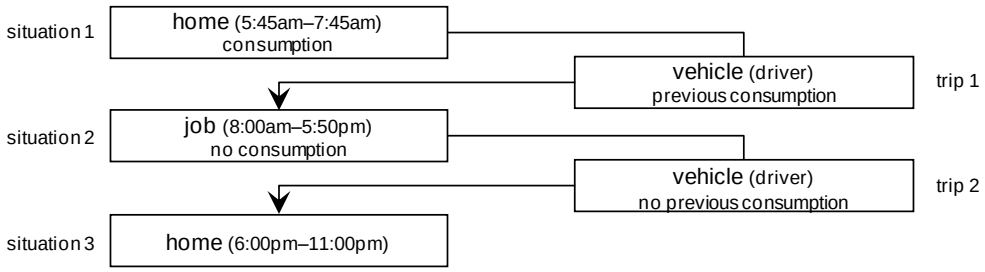


Figure 16: Example for conditions under which consumption has to be stated or not when describing a drive.

If the person restricted drug consumption because of driving, this always has to be mentioned when describing the drive, no matter if the drug effect is still noticeable or not (Figure 17).

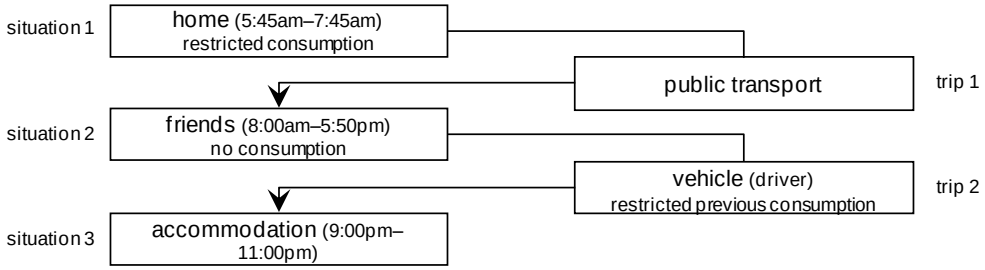


Figure 17: Example for stating restricted consumption previous to driving.

If a person has a business trip (excluded are trips to/from work), it has to be marked by additionally selecting the *other* response option and writing *job* in the corresponding text field.

Drug-related instruction

On days with drug consumption the exact timeframe of the consumption has to be reported. In the case of short consumption periods (e.g. one joint in ten minutes), the timeframe can be reduced to a point of time (e.g. one joint at 5pm).

To facilitate the reporting of the drug amount, the subjects have the opportunity to report the number of consumers with which they consume drugs and the drug amount that is consumed altogether, e.g. one joint with two co-consumers. The individual drug amount is calculated afterwards by the investigators. The highest response option for specifying the drug amount is the category *above 5 units*, which is treated as 6 units in the evaluation.

Medicines that are regularly used do not have to be reported in the daily report. This data is asked for in a paper and pencil questionnaire at the beginning of the study (Q-Start, Annex 17.2).

The subjects have to state if the drug consumption is planned or spontaneous. The consumption should be reported as spontaneous if it was decided to consume in the preceding situation. Planned consumption refers to situations in which drug use is very common, e.g. at weekends when meeting drug using friends. Whenever multiple drugs are used in a situation, the question on planned or spontaneous drug use always refers to the drug use in total. If a person consumes multiple drugs and the consumption of at least one of the drugs is spontaneous, the consumption is spontaneous in total.

Companion-related instruction

Companions are friends, family members and other persons with whom one consciously spends time with. Colleagues at work, school or university do not have to be listed unless one attendee uses drugs at work or at school. At a maximum, five companions can be listed. If the actual number of companions is larger, the subjects were instructed to list those five who best represent the group.

Only the companions' current behaviour should be regarded when stating the companions' drug use. It is not relevant if the companions used drugs before the situation in question.

11.3 Financial incentive

To make sure that the subjects continue to answer the daily questionnaire for four weeks until the end of the study period, a reward system was devised. It compensates every single effort carried out by the subjects over the whole study period. The raw structure of the reward system was derived from a study from Searles, Perrine, Mundt and Helzer (1995).

The main values in Figure 18 refer to the credits achievable by the users. The values in brackets refer to the controls' credits. Two considerations justify a higher total credit for the users. First of all, the study was more time consuming for the users than for the control group. The questionnaire's focus lays on driving and drug consumption. In the user group, most subjects consumed at least every second day. For each consumption episode, this group had to answer the corresponding questions. On the other side, the drug users had to reveal much more confidential information. They were asked to report illegal behaviour – their drug consumption. The hesitations to take part were much higher than for controls. Therefore, the incentives had to be great enough for this group to take part.

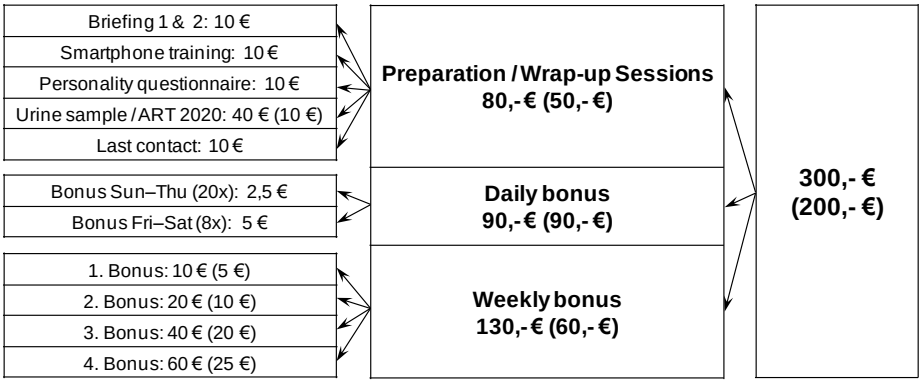


Figure 18: Credits for users and controls (in brackets).

The time delay between the daily occurrences and their reporting has an influence on memory performance and therefore on the quality of the data. Thus, the subjects had to send the protocols no later than two days after the date of the day they intended to report. If they sent it directly the next day, they got the complete daily bonus. If they sent it the day after, the daily bonus was halved. More money was paid for Fridays and Saturdays because it was assumed that consumption is higher at weekends. The time effort for reporting is higher then and the achieved data is more relevant for the detection of drug driving incidences and their circumstances.

Additionally, a weekly bonus was paid that made allowances for each successfully recorded week. If within one week, one protocol was missing, the weekly bonus was halved. If two or more protocols were missing, no weekly bonus was paid and the bonus for the next week was not increased.

For motivational issues, the daily bonus was reported on the display of the smartphone after sending the questionnaire. Once a week, the subjects got a PIN message that was sent by the investigators and contained information about the complete credits that were achieved. Figure 19 shows the maximum credits over the study period for the users (*good compliance (user)*) and the control group (*good compliance (control)*). The dotted lines refer to exemplary user subjects who omitted one (*moderate compliance (user)*) and four (*bad compliance (user)*) reports to show the impact of omissions on the total sum of credits.

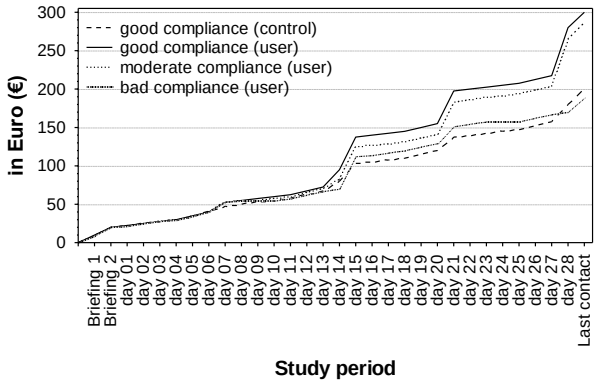


Figure 19: Maximum of achievable credits for user and control group over the study period.

11.4 Data consistency check

11.4.1 System-controlled consistency check

Logical data inconsistencies were immediately announced by the system when the respondent answered all questions of one level and switched to the next level. Errors had to be corrected before continuation. Some feedback did not indicate an error but a warning. Warnings were triggered by data that were not essentially wrong but rather unlikely (Table 11).

Table 11: System-controlled consistency check.

Variable	Condition	E*	W*	F*
All levels				
All	Missing data	X		
Day level				
Date	Feedback signal about weekday of reported date			X
Time wake up	No change of preset value (12am)		X	
Date	Date lies in future or more than two days in the past	X		
	Report already exists in database	X		
	Day lasts more than 48 hours	X		
Episode level				
	No episode has been reported	X		
	No trip has been reported between two situations		X	
	Last episode represents a trip		X	
Time	Time start of first episode differs from time wake up	X		
	Trip between two situations lasts longer than five hours		X	
	Episode overlap	X		
	Situations separated by a trip but no delay in time between situations	X		
	Situation lasts longer than 18 hours (determined by the system)	X		
Companion level				
	Passenger on trip but no companion listed	X		
Drug level				
Time	Consumption time lays outside of episode time	X		

*E=Error, W=Warning, F=Feedback

11.4.2 Person-controlled consistency check

11.4.2.1 Inspection focus

Not all data inconsistencies were detectable by system-controlled consistency checks. Several inconsistencies became apparent only through screening the entire context. Immediately after receiving the data at the study centre, each report was checked for inconsistencies by a study assistant (Table 12).

Table 12: Person-controlled consistency check.

Variable	Condition
Day level	
Sleeping time	Sleeping time=Time Wake up minus Time End last situation of previous day? (less sleeping time acceptable in the case of bad sleep quality)
Episode level (situation)	
	Do situations make sense in the course of the day? (e.g. job situation at unusual time)
	Last situation of previous day=first situation of next day?
Episode level (trip)	
	Do trips make sense in the course of the day concerning distance, %motorway/rural/city road? (e.g. long distance trips should occur twice – outward and return trip)
Time	Does time of a trip makes sense concerning distance and mode of transport?
Previous consumption	Previous consumption (restricted or not) reported for drives ↔ consumption in former situations of same day?
	No/abandoned previous consumption reported for trips ↔ no consumption/abdication specified in former situations of same day?
Reason for not driving	Previous consumption as reason → consumption in former situations of same day or high consumption on previous day?
	Subsequent consumption as reason → consumption in later situation of same day?
	No car available? (e.g. when outward trip was already travelled with another mode of transport) → *other reason*
Drug level	
	Subject uses drug in a situation but not the companions or vice versa?
	Subject uses drugs at job/school/university → companions?
	Consumption on trip possibly false statement?
Time	Time reported for drug consumption appropriate for consumed drug amount?
Companion level	
	No companions listed in particular situations in which companions are very likely? (e.g. at friends', at relatives', etc.)
	Companions in last situation of previous day=companions in first situation of same day?
	Comparing number of co-consumers with number of companions/drug consumption of companions (e.g. number of companions cannot be lower than number of co-consumers)
Drugs	Drug consumption of companions refers to consumption in current situation/trip?
Driver	Drug consumption of driver refers to previous consumption?

11.4.2.2 Data correction volume

The single data values that were collected via the smartphones add up to approximately 1.3 million values. In Table 13 the numbers of variables and the number of cases per data level are listed (the actual number of values per data level range in each individual case because of the adaptive nature of the questionnaire).

The subjects were called to discuss data inconsistencies approximately five to six times within the study period. The users had to be called more often (Mean=5.8) than the controls (Mean=4.8). Approximately 20,000 data values (~1.5% of all data values) had to be changed by correcting single values or by inserting/deleting whole levels.

Table 13: Data volume.

Level	Number of variables	Number of cases
Person-Level (VPID)	4	300
Day-Level (TID)	17	8,633
Episode-Level (EID)	35	68,635
Companion-Level (CID)	3	60,526
Drug-Level (DID)	7	11,969

12.Data quality

12.1 Comparison with existing data (representativity)

12.1.1 Driving

The Germany-wide survey Mobility in Germany 2008 (MiD 2008) was carried out in the tradition of the MiD 2002 and the western German KONTIV-surveys from 1976, 1982 and 1989. The survey provides representative data about the mobility of the German population. In 2008, 60,713 persons were randomly surveyed regarding their mobility behaviour on a predefined day over a 1-year period.

In order to get information about the representativeness of the driving behaviour that was reported within the GSS, the data were compared with the data from the corresponding sub-population within the MiD 2008 survey[24]. By applying the GSS in- and exclusion criteria, the total MiD sample of 60,713 subjects was reduced to 6,274 (German) or 808 (Bavarian) valid subjects with which the GSS data were compared (Figure 20). The MiD data were weighted to compensate for the presence of biases due to the sample selection, whereas the GSS data were not weighted. For the GSS data, the mean values were first calculated for each person. Then, the average of all persons was calculated in order to reach highest data comparability.

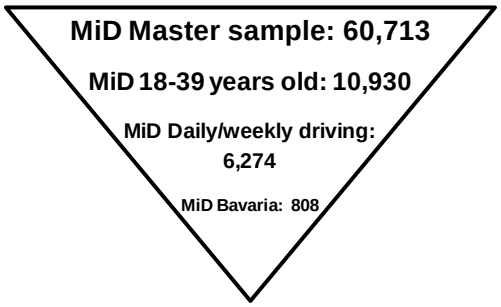


Figure 20: MiD sample.

The mean number of drives adds up to 2.03 drives a day for the German population and 1.96 for the Bavarian population according to the MiD data (Table 14)[25]. So, the mean number of drives for the Bavarian population is lower than the one of the German population in total. For the GSS data, the mean number of drives per day is 1.79 (user: 1.71; control: 1.94). The mean number of drives of the controls within the GSS sample corresponds very well to the values of the Bavarian sample, whereas the users drove slightly less often than the Bavarian population.

[24] The data were purchased from the “Clearingstelle für Verkehrsdaten und Verkehrsmodelle” in order to use them for own analysis.

[25] Business trips except trips to and from work are not included because the MiD data delivered no information about how business trips were travelled. Neither are those trips included that were additionally reported but not further specified (N_{MiD}=47). The minimum of zero drives within the GSS sample is due to one user who only had drives at work, which were excluded for this analysis.

Table 14 Descriptive data concerning the number of drives per day of the MiD/GSS sample.

			$N_{Subject}$	N_{Days}	M	Min	Max	SD
Drives	**MiD**	**Germany**	6,274		2.03	0	12	2.07
		Bavaria	808		1.96	0	12	1.87
	GSS	**All**	300	8,633	1.79	0	4.8	0.86
		User	200	5,730	1.71	0	4.8	0.85
		Control	100	2,903	1.94	0.62	4.43	0.87

When comparing the occurrence of drives in the course of the day, the MiD sample was not limited to Bavarian subjects nor to the sub-population who drives regularly. Three assumptions were adopted:

- Regional differences in the relative occurrence of drives in the course of the day between Bavaria and the rest of Germany are not expected
- The distribution of drives over the course of the day does not differ between persons who drive daily/weekly and those who drive monthly. If so, the difference is of no consequence since the fraction of the latter sub-group's drives is rather low.
- The GSS data were compared to all drives of the 18-39-year-old German-wide population. The MiD data consists of single days for each subject of the sample, whereas the GSS data obtains several days for each subject. Because the number of days is approximately equal for all subjects, biases resulting from the different structure of the data pools are not expected.

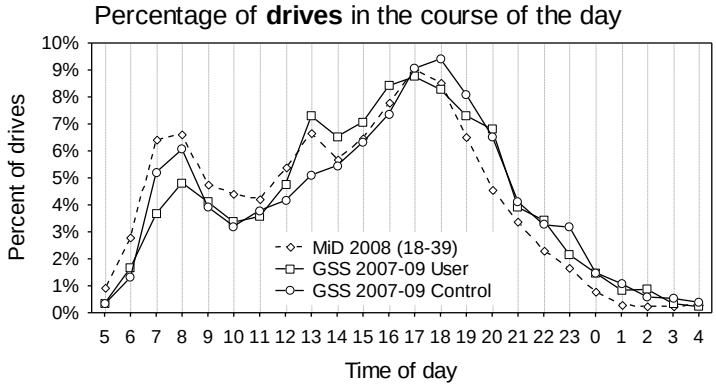


Figure 21: Percentage of drives in the course of the day for the MiD 2008 and the GSS user and control sample (the single values of all hours of the day sum up to 100% for each group).

The persons who participated in the study drove less frequently in the morning hours and more often in the evening and at night compared to the representative data (Figure 21). Here again, the controls' distribution of drives in the course of the day resembles the representative data better than the users'. The users drive less often in the morning hours.

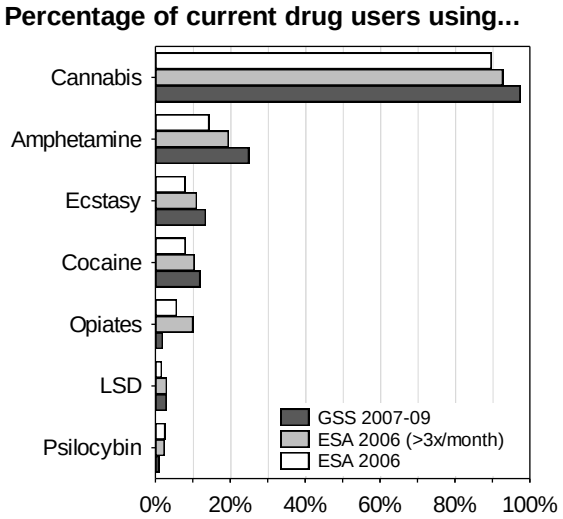
All in all, the number of drives and the distribution of drives in the course of the day of the present sample are comparable to the representative data. However, slight differences between the users of the GSS sample and the representative sample were found that might indicate a different driving behaviour of drug users. The

subjects' affinity for drug use could be related to a decreased total amount of drives per day and a decreased driving frequency in the morning.

12.1.2 Drug use

To find out if the drug using behaviour recorded in the GSS survey equals the representative data of the German population (ESA 2006), the percentages of subjects who were using cannabis, amphetamine, ecstasy, cocaine, opiates, psilocybin and LSD while participating in the study were compared to the 30-day prevalence of each drug measured in the Epidemiological Survey on Substance Abuse in Germany (ESA). Because the occurrence of less prevalent drugs especially could be higher when someone uses drugs more frequently (one inclusion criteria for the GSS study was regular drug use), the prevalence rates of the ESA 2006 data were also calculated for the comparable sub-group of regular users (>3x/month).

Figure 22 illustrates the percentage of the user group that is using the different drugs while participating in the GSS study (dark bar) compared to the drug prevalence values according to the ESA 2006 survey for the 18-39-year-old general German population (white bar) and those who regularly used drugs within the last month (grey bar). For all drugs except opiates, the agreement between the data pools is very good, especially when comparing the GSS data with the regularly using German sub-population. The difference regarding the current consumption of opiates may be based on two reasons. Firstly, opiate consumers often do not have a driver licence. Secondly, the focus of the study was on the "common" drug user who usually does not use opiates.



	GSS	ESA 2006 (>3x/month)	ESA 2006
Cannabis	97.5%	92.84%	89.79%
Amphetamine	25%	19.59%	14.38%
Ecstasy	13.5%	11.11%	8.01%
Cocaine	12%	10.46%	8.07%
Opiates	2%	10.1%	5.75%
LSD	3%	3.1%	1.77%
Psilocybin	1%	2.48%	2.63%

Figure 22: Drug prevalence for different substances within the GSS survey (dark bar) and for the 18-39-year-old German population that currently uses drugs (white bar) and uses drugs regularly (grey bar), respectively (ESA).

12.2 Previous consumption

12.2.1 Description

The main analyses that were conducted in this paper are based on information about the current drug use behaviour that was received from the daily questionnaires. Nonetheless, it is of interest if the current drug use behaviour surveyed in the present study is typical for the subject.

For this purpose, the drug use history that was reported by the participants is outlined in this chapter. Moreover, the information about previous drug use behaviour is compared to the current behaviour to be able to decide on if the latter sufficiently represents the subjects' general drug use experience.

The following questions were asked in a questionnaire at the beginning of the study (Q-Start; Annex 17.2) to gain information about the subjects' previous experience with drugs (Table 15).

Table 15: Q-Start questions concerning previous drug use.

Question
Have you ever taken any of the following drugs (cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin and sniffing agents)? If yes, when was the first time? How many years ago?
From the first time to this day, how often have you taken the following drugs? (never, 1x, 2x, 3-5x, 6-9x, 10-39x, ≥40x)[26]
How long has it been since you have taken the following drugs for the last time? (<1 month, 1-5 months, 6-11 months, ≥1 year, ≥2 years, ≥5 years, never used)

The questions were asked for the drugs cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin and sniffing agents. Additionally, a miscellaneous field was given to be able to specify other, not listed drugs. In this category, the following drugs were mentioned: other psychoactive plants[27], non-prescribed methylphenidate, ephedrine, phencyclidine, ketamine, GHB, spice, chrystal, tilidine, barbiturates and benzodiazepines. Four subjects had experience with synthetic opioids as maintenance anti-addictive. One subject used methadone in the past, whereas the remaining three subjects are still in treatment with methadone and buprenorphine, respectively, and additionally use other drugs (cannabis, cannabis and heroin, heroin).

Almost all drug users (N_{User}=200) within the sample have used cannabis more than forty times in their lifetime. The drug users' experiences with other drugs varied (Figure 23).

[26] "x" means times of use.
[27] Hawaiian baby woodrose, mescalin, tryptamine, salvia divinorum, brugmansia.

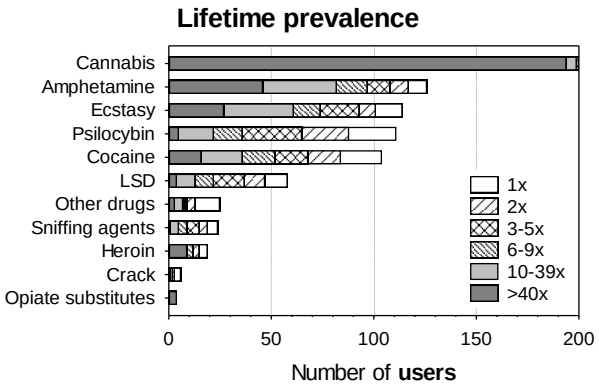


Figure 23: Lifetime drug use frequency per drug for users (N_{User}=200).

Figure 24 and Figure 25 show the age of onset of drug use (left figure) and the number of subjects within the user group (N_{User}=200) that used each drug at least once in a lifetime (right figure). The earliest mean onset at the age of 15.6 was found for cannabis, followed by sniffing agents at age 17.1. Amphetamine (18.6), ecstasy (18.6), psilocybin (18.7) and LSD (18.9) were used for the first time at the age of 18 to 19. For all other drugs (heroin: 19.9; cocaine: 20.0; crack: 20.7; all other drugs: 20.1), the users were around 20 years old when they used it for the first time.

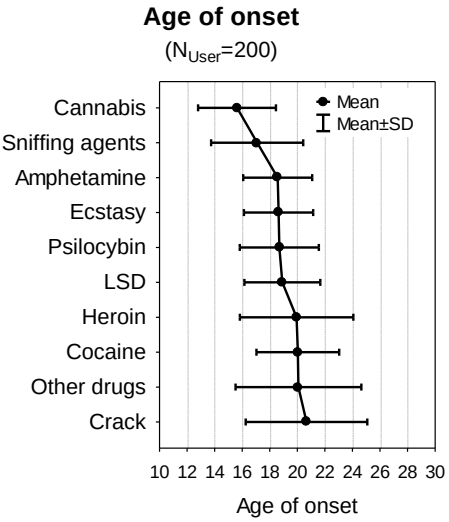


Figure 24: Mean age of onset per drug for users (N_{User}=200).

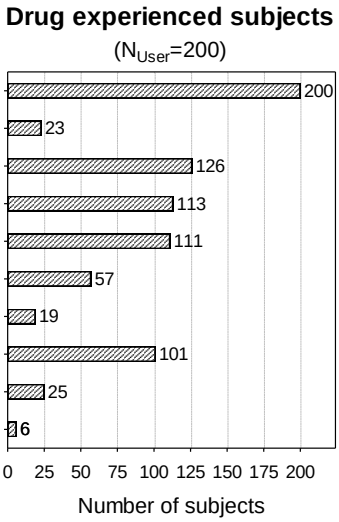


Figure 25: Number of drug experienced subjects per drug for users (N_{User}=200).

Figure 26 shows the time when the subjects used the different drugs for the last time. All users are currently using drugs. Five persons did not use cannabis within the last month. Other drugs were used instead within the previous month. One person was regularly using ephedrine, one amphetamine, one amphetamine, ecstasy and sniffing agents and another two heroin, one of which additionally used buprenorphine.

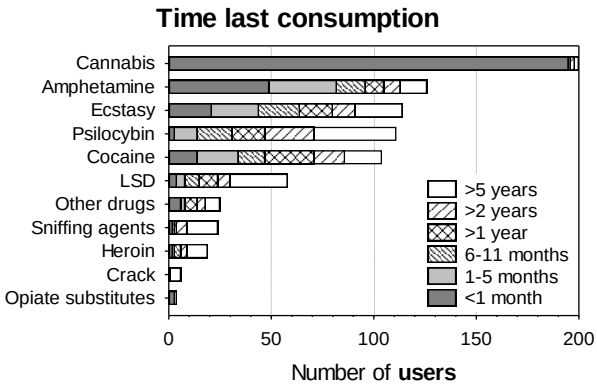


Figure 26: Time since last consumption per drug for users (N_{User}=200).

On the basis of the data about the frequency of previous drug use, different user classes were categorised by exploratory data analysis based on a face validity approach and not a formal analytic procedure like a cluster analysis (Table 16). In the first step, the mean values of the frequency of using stimulants (*Stim*), hallucinogens (*Hallu*), "high potential" drugs (*Her*) and other drugs (*Oth*) were calculated. Amphetamine, ecstasy and cocaine were subsumed in the *stimulants* category, psilocybin and LSD in the *hallucinogens* category. The *high potential drug* category contained the drugs heroin and crack because of their high potential for abuse. Moreover, opiate substitutes were subsumed in this category. The remaining drugs were summarised within the *other drugs* category. The mean value of each category was calculated with the following values of the lifetime frequency of each drug: *1x*=1x, *2x*=2x, *3-5x*=4x, *6-9x*=7x, *10-39x*=24x, *>40x*=40x. If the mean value was above 10, the drug use concerning this category was classified as crucial. Table 16 shows the different user classes drawn from this categorisation.

Table 16: User classes based on frequency of previous drug consumption and number of users.

		Lifetime drug consumption			N_{User}=200
User class	**Class description**	**Cann**	**Stim/Hallu/Oth**	**Her**	
CanOnly	Cannabis only	**>0x**	0x	0x	40
CanOthLow	Cannabis and sometimes stimulants and/or sometimes hallucinogens and/or sometimes other drugs and/or sometimes high potential drugs	**>0x**	<10x	<10x	75
CanOthHigh	Cannabis and oftentimes stimulants and/or oftentimes hallucinogens and/or oftentimes other drugs and/or sometimes high potential drugs	**>0x**	**>10x**	<10x	76
CanHer	Cannabis and oftentimes high potential drugs	**>0x**	not specified	**>10x**	9

Figure 27 shows the users' profile concerning the frequency of drug use in lifetime for the different user classes. The classification separates the users quite well into different user types. The cannabis lifetime frequency does not differ between the four classes - *CanOnly* (cannabis only), *CanOthLow* (cannabis and sometimes other drugs), *CanOthHigh* (cannabis and oftentimes other drugs) and *CanHer* (cannabis and oftentimes high potential drugs). All users used cannabis quite often. 40 users

have only used cannabis in their lifetime (*CanOnly*). 75 subjects also used amphetamine, ecstasy, cocaine and psilocybin sometimes and very rarely LSD, sniffing agents and other drugs except opiates and crack (*CanOthLow*). 76 users used stimulants and hallucinogens quite often and sometimes sniffing agents and other drugs including heroin (*CanOthHigh*). The remaining nine users are classified as one group because of their experience in heroin (*CanHer*). This user class also used all other substances quite often.

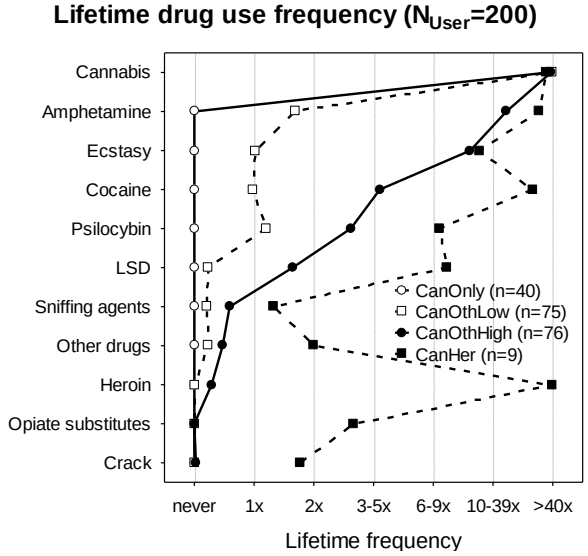


Figure 27: Lifetime drug use frequency in user group for the user classes "CanOnly" (cannabis only), "CanOthLow" (cannabis and sometimes other drugs), "CanOthHigh" (cannabis and oftentimes other drugs) and "CanHer" (cannabis and oftentimes high potential drugs).

12.2.2 Comparison of former and current consumption

In a next step, it was examined whether the data about the lifetime experience with drugs suits the current consumption data that were reported within the 4-week study period. Almost all subjects used cannabis while participating in the study (for detailed information see Chapter 14.5). All other substances were used rather infrequently. So, they were summarised as *other substances*. Five subjects did not use cannabis within the study period. Instead, one used amphetamine (on 4.3 days)[28] and ecstasy (on 1.1 days), one ephedrine (on 28.9 days), one buprenorphine (on 30 days) without concomitant drug use, one amphetamine (on 13.1 days) and cocaine (on 3.7 days) and one heroin (on 16.1 days) and zopiclone (on 10.7 days). Those were excluded from all analyses.

The users who reported that they had never used other drugs than cannabis in their lifetime (*CanOnly,* N_{User}=40) only used cannabis while participating in the study (Figure 28). Of those who reported that they have sometimes used other drugs in their lifetime (*CanOthLow*), 27% (N_{User}=20) reported the use of other drugs while

[28] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of days with drug use divided by number of reported days and multiplied by 30).

participating. Of those who oftentimes used other drugs before participating in the study (*CanOthHigh*), 60% (N_{User}=44) reported current consumption of other drugs. All users who have used heroin, crack and opiate substitutes before (*CanOthHer,* N_{User}=7) used other drugs than cannabis within the survey period.

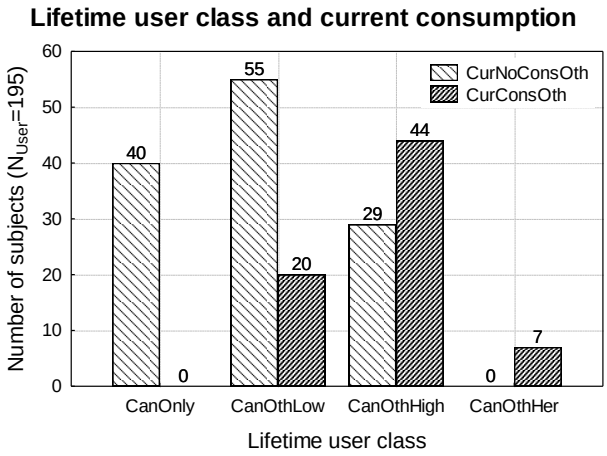


Figure 28: Lifetime user classes, depending on current consumption of other drugs than cannabis (lifetime user class: CanOnly=Cannabis only, CanOthLow=Cannabis and sometimes other drugs, CanOthHigh=Cannabis and oftentimes other drugs, CanOthHer=Cannabis and oftentimes high potential drugs; current use of other drugs than cannabis: CurConsOth=Yes, CurNoConsOth=No; N_{User}=195).

The higher percentage of users who use other drugs than cannabis in those user classes that reported higher use of other drugs in the past indicates a good consistency of the queried information and shows that the current drug consumption behaviour is a good parameter for describing the drug use experience in general.

At the end of the study, the subjects were also asked if their drug use and driving behaviour within the study period was comparable to their usual behavioural habits. 19 subjects (6.4%) said that they changed their drug use behaviour – 15 reduced it, 4 consumed more – and 54 subjects (18.3%) said that they had become more aware of their drug use but did not change it (analogous driving behaviour: 1% were more mobile; 2.7% drove with more care).

12.3 Urine sample – toxicological analysis

12.3.1 Method

All subjects were required to randomly submit to a urine drug test once within the study period. The urine samples were analysed at the Institute of Legal Medicine in Wuerzburg and Munich, respectively. In Table 17 the applied immunoassay technologies, the analysed substances and the corresponding cut-off values are listed.

Table 17: Immunoassay technologies that were applied for the toxicological analysis of the urine samples and corresponding cut-off values.

Institute of Legal Medicine	Wuerzburg	Munich
Assay	AxSym-Assay (Abbott)	CEDIA-Assay (Microgenics/Thermo Fisher)
	Cut-off values	
Cannabinoids	25 ng/mL	25 ng/mL
Amphetamines	600 ng/mL	200 ng/mL
Cocaine-Metabolites	300 ng/mL	100 ng/mL
Opiates	200 ng/mL	200 ng/mL

Because the amount of substrates in the urine cannot be interpreted quantitatively, the sample outcome was categorised dichotomously as either "positive" or "negative". The degree of correspondence between the urine screening and the recorded drug use was assessed by examining and relating the following data:

- Screening result
- Time difference between urine sample collection and last drug use
- Amount of consumed drug at last drug use

For the latter, a timeframe of 96 hours back from the last drug use episode was considered to avoid biases arising if the consumed drug amount in the last drug situation was considerably smaller than the one consumed – perhaps almost shortly before – in the drug situation before the last.

12.3.2 Agreement between urine sample and recording

295 urine samples were collected and tested for four different drugs or classes of drugs of abuse[29]. All urine analysis of the controls' samples resulted in a negative outcome. The following criteria were applied to decide on which urine samples were included in the further analyses. First of all, it was determined which user could potentially have or actually has a positive result on the different substances. Four information sources were used:

- Positive urine sample
- Report on current drug use behaviour while participating in the study (Q-Daily)
- Statement about standard drug use behaviour (first contact)
- Statement about drug use behaviour within the previous 30 days (Q-Start)

All urine samples with a lower creatinine value than 20 dl/ml and a negative drug screening were excluded from analysis because a lowered creatinine level could implicate that the sample is diluted and a false negative outcome is likely to occur (N_{User}=12, 6.1%; compared to $N_{Control}$=13, 13.1%). Samples were also excluded from the analysis when relevant reports previous to the urine collection were missing and

[29] Two subjects (two users) refused to give a urine sample because they feared that this could have a negative impact on data privacy. Three subjects (two users and one control) suddenly cancelled the study after approximately two weeks before the urine sample could have been collected.

the relation between the reported drug use in the available reports and the urine screening could thus be not interpreted.

Five samples were positive for cannabinoids and amphetamines, respectively, even though no drug use was reported within the 5-25 available previous days before the urine was collected (false positive). It was tried to collect the urine sample after approximately two weeks to make sure that enough information would be available about all relevant previous drug use. When the data collection started in Munich, the investigators were not constantly on site yet. So, the study procedure had to be adjusted to the time the investigators were present in Munich. That is why some subjects had only reported a few days before they had to deliver the urine sample. In this case, false positive samples could result from the fact that not all relevant previous consumption was reported. All other false positive samples might indicate that the subjects forgot to report the drug use in question. Nevertheless, since in the previous survey an underreporting leads to conservative results, the false positive results were ignored.

Of the remaining samples of the subjects who used the analysed substance classes within the study period previous to the urine sample collection, 80% were positive for cannabinoids, 28% were positive for amphetamines, 21% were positive for cocaine-metabolites and 100% were positive for opiates (absolute numbers in Table 18). The three opiate-positive samples were ascribed to one subject who was using an opioid medicine and two subjects who were using heroin.

Table 18: Urine sample description and outcome, depending on days since last drug use.

		Cannabis		Amphetamines		Cocaine		Opiates	
Regular/previous/current drug use		192		76		44		6	
Low creatinine & negative sample		7		4		–		–	
Relevant reports missing		2		1		–		–	
		pos.	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
No previous drug use reported		1	–	4	28	–	25	–	3
Number of analysed samples		182		39		19		3	
		pos.	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**	**pos.**	**neg.**
Samples with previous drug use		145	37	11	28	4	15	3	–
Days since drug use:	**max. 1 day**	117	10	5	–	2	–	1	–
	2-4 days	22	14	6	10	2	6	2	–
	5-7 days	6	7	–	5	–	3	–	–
	>7 days	–	6	–	13	–	6	–	–

The absolute numbers of the screening results for different time lags between urine sample collection and last drug use (i.e. max. 1 day, 2-4 days, 5-7 days, >7 days) show that the higher the time delay, the more likely a negative screening outcome is (Figure 29). Figure 30 to Figure 32 show the relation between the time difference and the consumed drug dose and the outcome of the drug screening for the different substance classes: cannabinoids, amphetamines and cocaine-metabolites. Opiates were not considered because the results are clear concerning opiates. For the other substances, a sample is positive in most of the cases when the subjects consumed a larger amount of drugs or the drug consumption took place not far in the past.

Nonetheless, there are no definite criteria for determining the agreement between the screening outcome and the drug amount/time difference between drug use and sample collection. Besides, there is no exact information about the dose that was actually consumed by the subjects. The dose was reported as number of units (e.g. joint/pipe/cookie/tea for cannabis, line/inhalation for cocaine, line/pill for amphetamine, etc.) and not as mg. The subjects were asked in the beginning of the survey how many mg they use when they consume a regular unit. It turned out that very few were able to make clear the exact dose that they consume.

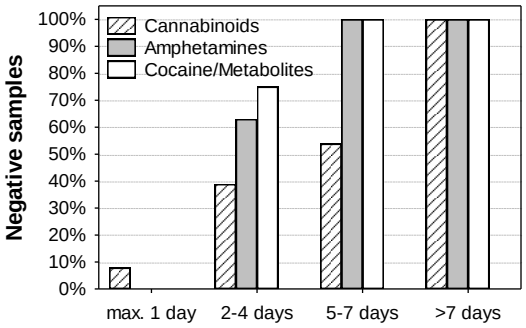


Figure 29: Percentage of negative urine samples, depending on the time difference between urine sample and last drug consumption.

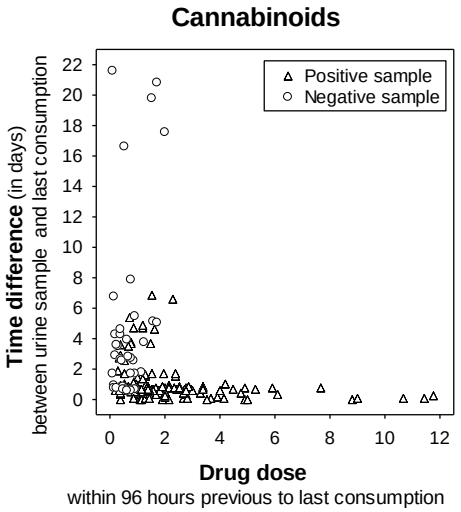


Figure 30: Relation between outcome of urine analysis and time difference to previous consumption and consumed units of cannabis (e.g. joint/pipe/cookie/tea).

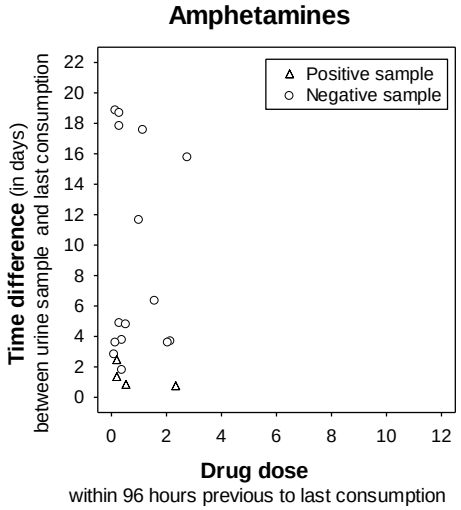


Figure 31: Relation between outcome of urine analysis and time difference to previous consumption and consumed units of amphetamines (e.g. line/pill).

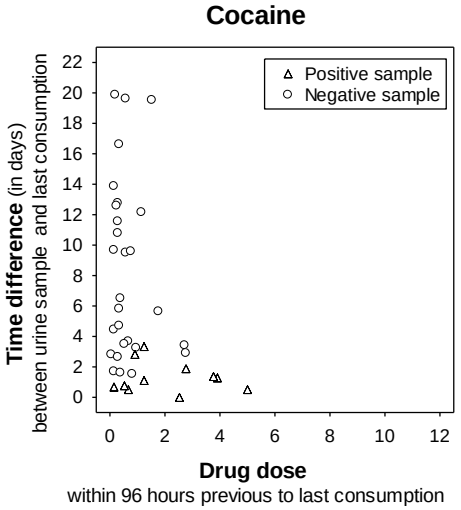


Figure 32: Relation between outcome of urine analysis and time difference to previous consumption and consumed units of cocaine (e.g. line/inhalation).

All in all, the subjects' statements about their drug use behaviour seem to be reliable because most screening results can be explained by the previous drug use that was reported. The differing statements slightly implicate both an underrating (false

positive outcomes) and an overrating effect (negative outcome with previous consumption within the last day).

13.Data pre-processing

To estimate the proportion of DUI as accurately as possible, BACs and THC blood plasma concentrations were calculated by using the information about the consumed doses of alcohol and cannabis[30], respectively.

13.1 Alcohol – Calculation of blood alcohol concentration

13.1.1 Rationale of calculation

For alcohol, the following steps of calculation were applied (Figure 33):

(1) Conversion of the amount of the different kind of drinks in gram alcohol
   - 1 litre beer (5% alcohol by volume)=40g
   - 1 litre wine (10% alcohol by volume)=80g
   - 2cl=0.02 litre liquor (40% alcohol by volume)=6.4g

(2) Because the periods of consumption vary from minutes to several hours, it was decided to assume a constant consumption over the whole consumption period. Therefore, the amount of consumed alcohol (in g) was equally divided into as many 15min-intervals as the period of consumption comprises.
   - 40g alcohol from 7:00pm-7:45pm
   - 3x15min-intervals=40g/3=13.3g per interval

(3) BAC calculation using the Widmark Formula (Widmark, 1932) for each interval[31]. The BAC of a 15min-interval consists of the BAC due to the currently consumed amount of alcohol plus the remaining BAC level from the intervals before.

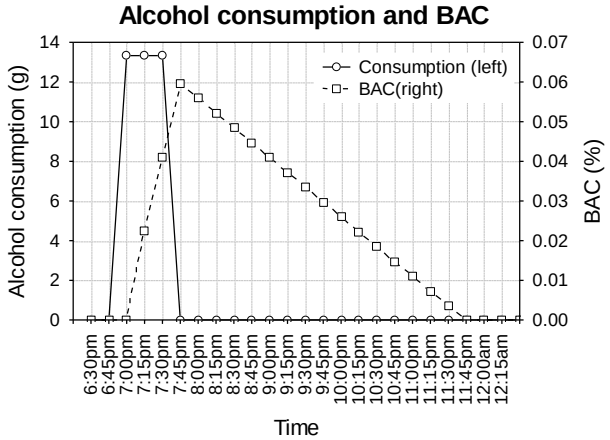


Figure 33: Calculated BAC for a male person (85kg) who consumes 40g alcohol from 7:00-7:45pm.

[30] For the other substances, no valid procedure to estimate the substance concentrations is available.

[31] The following assumptions were made: body weight or mean body weight for missing values (males=77 kg; females=64 kg), reduction factor: males=0.7, females=0.6; catabolic degration rate=0.015% BAC per hour (Madea & Dettmeyer, 2007).

(4) By matching the resulting 15min-intervals with the basic time-structure of episodes (situations and trips, Figure 34), for each episode the BAC is provided for the beginning and the end of the episode.

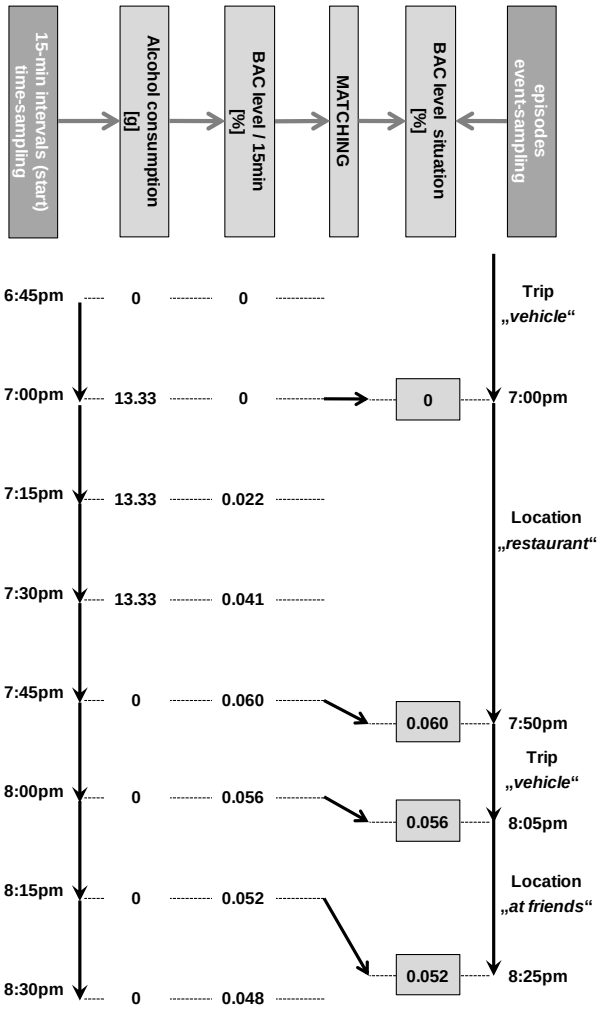


Figure 34: Illustration of transferring the BAC values from time-sampling to the time-points of the event-sampling of real episodes.

13.1.2 Constraints

(1) The amount of 154 drinks (out of 5,804=2.6%) could not be calculated automatically because the drinks were mix drinks (e.g. gin tonic). For them, the amount of alcohol was calculated manually according to their standard ingredients.
(2) A consumption of any alcohol dose in the middle of a 15min-interval (e.g. 7:05pm or 7:10pm) will result in a BAC value of zero at the beginning (7:00pm) and a BAC value of a 15min elimination period at the end of the interval (7:15pm).
(3) If a positive BAC remains after a period of sleep, the BAC is calculated by using a linear approximation of the Widmark Formula, starting with the BAC level when waking up until the BAC converges to zero. If further alcohol is consumed before the BAC level from the day before reaches zero, the BACs are added.

13.2 Cannabis: Calculation of THC blood plasma concentration

13.2.1 Rationale of calculation

For THC, the following steps of calculation were applied (Figure 35):

(1) Calculation of the total amount of consumed THC (in mg) regarding the number of co-consumers. For this procedure, a mean amount of 15mg per joint was assumed, which is a usual dose according to Madea and Dettmeyer (2007).
   - Consumption of 3 joints with 4 co-consumers: 3*15mg/(4+1)=9mg per person

(2) Because the periods of consumption vary from minutes to several hours, we decided to assume a constant consumption over the whole consumption period. Therefore, the amount of consumed cannabis (in mg) was equally divided into as many 15min-intervals as the period of consumption comprises.
   - 3 joints with 4 co-consumers from 7:00pm-7:50pm
   - Consumed mg: 3*15mg/(4+1)=9mg per person
   - 3x15min-intervals=9mg/3=3mg per interval and person

(3) Calculation of the THC blood plasma level using the data of Sticht (G. Sticht, personal communication, December 2009), which describe the nonlinear elimination curve of THC in 15min-intervals (Annex 17.4). The THC blood plasma level at the end of a consumption-period that comprises three 15min-intervals (e.g. 7:50pm in our example) is calculated as follows:
   - THC blood plasma level of the last interval (7:30pm-7:45pm), 3mg at 7:30pm eliminated for 15min plus
   - THC blood plasma level of the previous interval (7:15pm-7:30pm), 3mg at 7:15pm eliminated for 30min plus
   - THC blood plasma level of the first interval (7:00pm-7:15pm), 3mg at 7:00pm eliminated for 45min

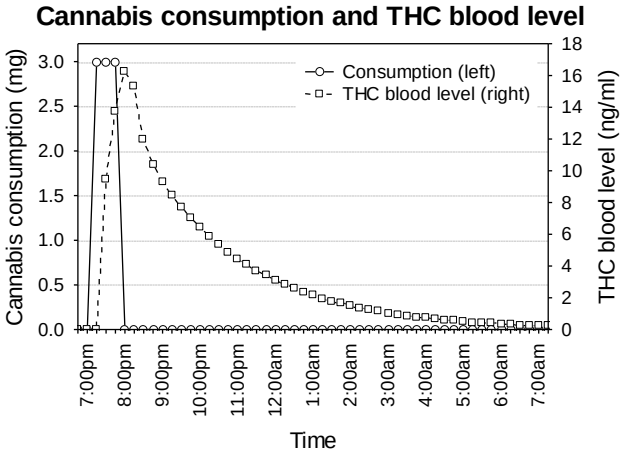


Figure 35: Calculated THC blood plasma level for a person who smoked 3 joints (3x15mg) from 7:00-7:50pm with 4 co-consumers.

(4) By matching the resulting 15min-intervals with the basic time-structure of episodes (situations and trips, Figure 34), for each episode the THC blood plasma level is provided for the beginning and the end of the episode.

13.2.2 Constraints

(1) Out of 5,680 THC consumption units in the database, 4,116 (72.5%) were smoked as joints and 1,548 (27.3%) where inhaled as pipes. 16 consumption units (0.28%) were consumed as cookies or tea. For all kinds of drug intake, the procedure for the calculation of the THC blood plasma level described in this chapter is applied. Because of different absorption and elimination processes depending on the consumption method, this is not correct but was considered as an acceptable falsification, primarily because the number of cookies or tea intakes was so low.
(2) A consumption in the middle of a 15min-interval (e.g. 7:05pm or 7:10pm) will result in a THC blood plasma value of zero at the beginning (7:00pm) and a THC blood plasma value of a 15min elimination period at the end of the interval (7:15pm).
(3) If a positive THC blood plasma level remains after the sleep period of a subject, the THC blood plasma level is transferred to the subjects' protocol of the next day. In the case of further consumption before the THC blood plasma level from the day before reaches zero, the THC blood plasma values are added.

14.Results

14.1 Glossary

This chapter summarises and defines main terms that are used within the report to facilitate an easy understanding and orientation within the following results section.

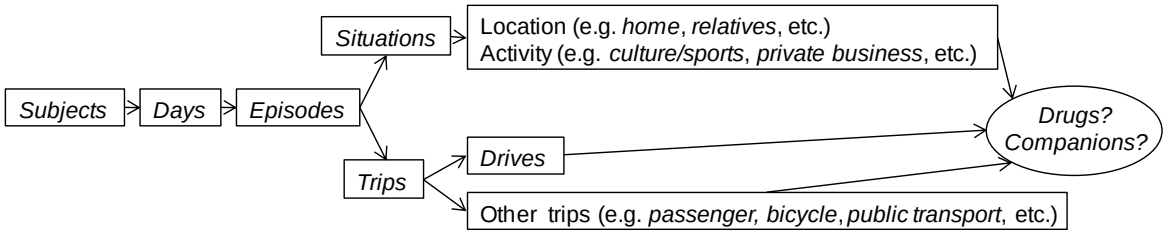


Figure 36: Terminology of daily data points.

The daily data consist of different *days* of each subject, which are divided into as many daily *episodes* as each subject had on each day (Figure 36). An *episode* can be a *situation* or a *trip*. *Situations*, in turn, are locations (e.g. *home,* etc.) and activities (e.g. *culture/sports,* etc.). *Trips*, on the other hand, are divided into *drives* that were travelled as driver of a motor vehicle or any other trip (e.g. *passenger*, *bicycle*, *public transport*, etc.). Data about the consumed *drugs* and the accompanying *companions* are available for each situation and trip. In Table 19 all main terms are described as they are used within the results section of this report.

Table 19: Definition of main terms used in results section.

Term	Definition
User	Drug using subject who used cannabis at least once while participating in the study
Episodes	Situations and trips
Situations	Locations and activities
Trips	Motorised private transport as driver (moped, motorcycle, vehicle, transporter, truck) and all other trips (passenger, bicycle, etc.)
MPT	Motorised private transport (either as driver or as passenger)
Drive	Motorised private transport as driver of a motor vehicle (motorised private transport as passenger is not included)
Drug	Psychoactive substance (illegal drugs, alcohol, prescription medicines)
Stimulants	Amphetamine, cocaine, ecstasy
Residence	Rural: < 50,000 residents, urban: < 500,000 residents, city: > 500,000 residents
City drives	Drives that were travelled on city roads to 70%
NoCity drives	Drives that were travelled on city roads to less than 70%
DUI	Drives under the influence of cannabis (THC≥1ng/ml) and/or alcohol (BAC≥0,01%) and/or any other substance (according to the calculation described in Chapter 13)
Conflicts	Trips associated with drug driving: drives that were consciously travelled under influence (*consumption as usual*), drives that were travelled after reduced consumption (*restricted consumption*) and trips for which the subjects stated having abdicated driving under influence by either abstaining from drug use (*consumption abdication*) or abstaining from driving (*drive abdication*) (for a detailed description of the different conditions see Chapter 14.8)
Weekday	All hours after 9pm on Sundays until 9pm on Fridays
Weekend	All hours after 9pm on Fridays until 9pm on Sundays
Hour	Lasts from 29 min before until 30 min after the full hour (e.g. 5=4:31am-5:30am)

14.2 Data overview

This section gives an overview of the magnitude of all reported daily data points. The absolute numbers of the reference parameters are shown in Table 20 to Table 22.

Table 20: Available data (absolute numbers and percent): overview (N_{User}=195; $N_{Control}$=100).

	User (N_{User}=195)		Control ($N_{Control}$=100)		Total (N_{Total}=295)	
	N	%	N	%	N	%
Days	5,586		2,903		8,489	
...with drug use (% of days)	4,373	78.3%	839	28.9%	5,212	61.4%
...with drives (% of days)	3,605	64.5%	2,046	70.5%	5,651	66.6%
Episodes	43,967		23,571		67,538	
...Situations (% of episodes)	25,360	57.7%	13,487	57.2%	38,847	57.5%
...Trips (% of episodes)	18,607	42.3%	10,084	42.8%	28,691	42.5%
...Drives (% of trips)	9,553	51.3%	5,646	56%	15,199	53%

Table 21: Consumption episodes (absolute numbers and percent): overview of the users' data (N_{User}=195; for alcohol additionally for controls – $N_{Control}$=100).

		Situations		Trips			
				No drives		Drives	
		N	%	N	%	N	%
Any drug		7,479	29.5%	315	3.5%	46	0.5%
Alcohol	**User**	3,042	12%	209	2.3%	14	0,1%
	Control	1,040	7.7%	25	0.6%	4	0.04%
Cannabis		5,528	21.8%	120	1.3%	32	0.3%
Amphetamine		254	1%				
Ecstasy		69	0.3%	3	0.03%		
Methadone/buprenorphine		58	0.2%				
Cocaine		50	0.2%				
LSD		8	0.03%	2	0.02%		
Sedatives		8	0.03%				
Heroin		5	0.02%				
Psilocybin		2	0.01%				
GHB		2	0.01%				
Spice		2	0.01%				
Methylphenidate[32]		3	0.01%				
Salvia Divinorum		1	0.004%				

Table 22: Modes of transport (absolute numbers and percent): overview (N_{User}=195; $N_{Control}$=100).

Mode of transport	Number (and percent) of trips		
	User (N_{User}=195)	Control ($N_{Control}$=100)	Total (N_{Total}=295)
Foot/bicycle/other	4,267 (22.9%)	2,197 (21.8%)	6,464 (22.5%)
Taxi	292 (1.6%)	59 (0.6%)	351 (1.2%)
Public transport	2,207 (11.9%)	1,055 (10.5%)	3,262 (11.4%)
MPT passenger	2,288 (12.3%)	1,127 (11.2%)	3,415 (11.9%)
MPT driver alone	6,793 (36.5%)	4,062 (40.3%)	10,855 (37.8%)
MPT driver companion	2,760 (14.8%)	1,584 (15.7%)	4,344 (15.1%)

[32] Non-prescribed methylphenidate.

14.3 Main points of data analysis

By the study, a broad range of data from different sources could be collected (Chapter 10). The results concentrate on basic information about the...

…prevalence of psychoactive substances within the German driver population

- How often does DUI occur within the study sample?
- How high is the proportion of DUI in the general population (estimated by the survey results)?

…situational aspects associated with drug use and DUI

- How do people spend an average day?
- When and what kind of substance do people use?
- When do people drive a vehicle and when do they use other modes of transport?
- What are the situational characteristics of DUI and decisions against DUI?

…person-related factors of drug use and DUI

- Does everybody who uses drugs and drives regularly commit DUI?
- Do people who drive a lot commit more DUI than others?
- Do heavy users commit more DUI than others?
- Does accute cannabis intoxication and long-term drug use affect the psychometric performance measured by the computer-based Act & React Test System (ART) 2020 Standard test battery?
- Do subjects who were conspicuous in road traffic before (measured by the records in the Central Register of Traffic Offenders) commit more DUI compared to those who had no entry in the register?
- Do subjects who reported dangerous traffic situations while participating commit more DUI compared to those who had no dangerous traffic situation?
- Are there differences in personality between users and controls and between those users who commit DUI and those who do not?
- Are users compared to controls more at risk of mental illness?
- Can social influences be identified that are associated with drug use and DUI?
- Can attitudes be identified that are associated with drug use and DUI?
- Does sanctioning and enforcement deter from DUI?

14.4 Structure of days

14.4.1 Sleep-wake ratio

To compare the sleep-wake ratio of weekdays and weekends, all reported hours after 9pm on Fridays until 9pm on Sundays were summarised as weekend hours. All remaining hours were classified as weekday hours. Obviously, the subjects generally went to bed later at night and got up later in the morning on weekends than on weekdays (Figure 37). Between 4am and 6am on weekends, they were awake on up to 30% of the reported hours (i.e. days). On weekdays, they were awake at this time in less than 10% of the days. Compared to controls, the users were more awake at night-time and more asleep between 7am and noon on both weekends and weekdays. So, both weekends and being a drug user shifts back the sleeping period to later at night until later in the morning.

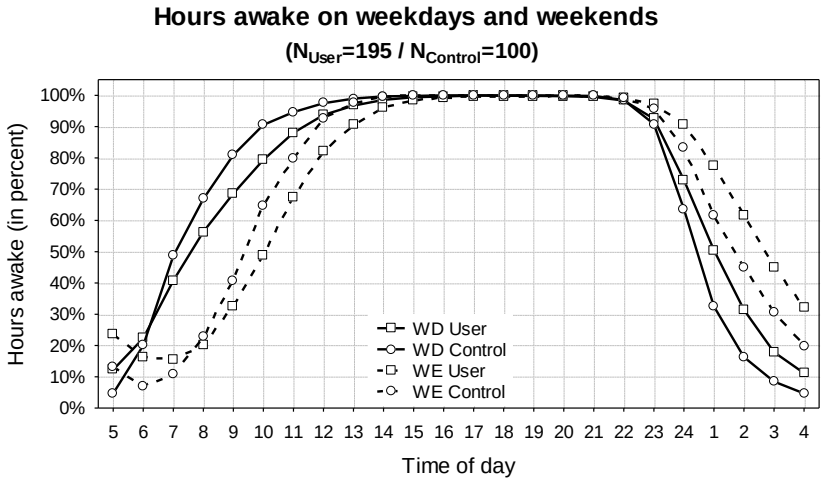


Figure 37: Hours awake on weekdays (WD) and weekends (WE) for users (N_{User}=195) and controls ($N_{Control}$=100) in percent - naps during the day are not included.

14.4.2 Structure of locations/daily activities

The structuring of each daily report was described in Chapter 10.1.1. The subjects listed all situations and trips in chronological order. For each situation, they specified the location or the activity they carried out by using the predetermined categories *at home*, *friends*, *relatives*, *job*, *school*, *private business*, *culture/sports*, *restaurant/bar*, *club*, *event*, *outside* or *excursion*. Moreover, a miscellaneous response was provided to express locations/activities that could not be expressed by the given response alternatives. For a clear presentation of the locations and daily activities, all specifications that were mentioned through the miscellaneous category were subsumed to the predetermined categories (e.g. *cinema* to *culture/sports*, *garden shed* to *at home*, etc.). Besides, the categories *job* and *school* were put together and the category *excursion* was subsumed to the category *outside*. The situations were assigned to the 24-hour timeline of a day according to their length (e.g. the situation *at home* from 5:00pm-7:20pm was assigned to the hours 17, 18 and 19). Because

more than one situation could take place within one hour, the number of situations per time category exceeds the number of days and varies according to the frequency of situations per time category. Therefore, no absolute numbers but percentage values per time of day are shown in the following figures.

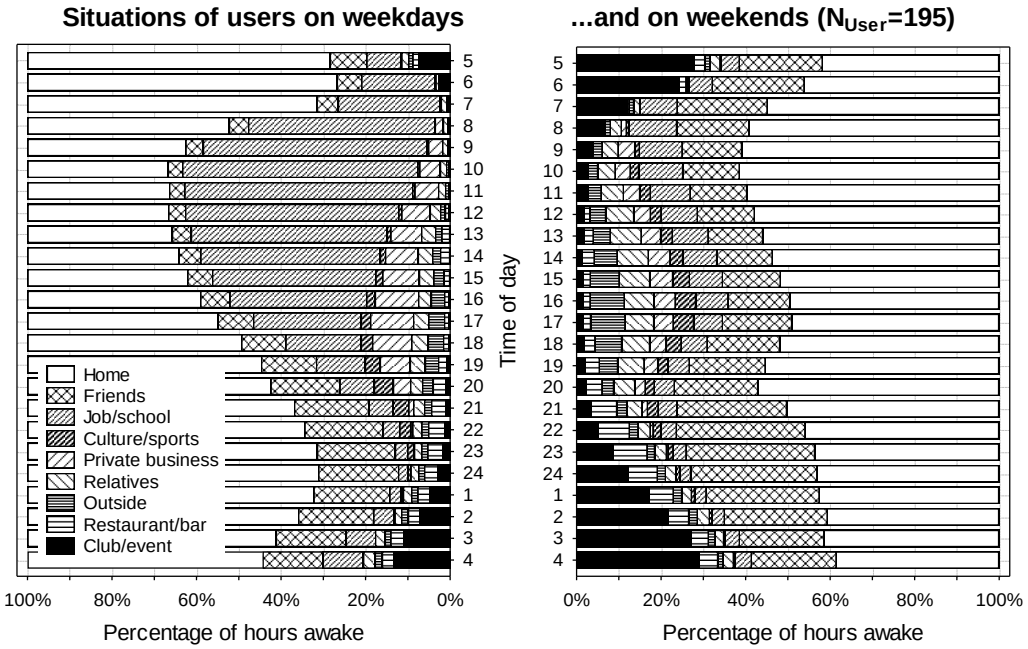


Figure 38: Proportion of time that was spent on different activities/at different localities for weekdays and weekends of users (N_{User}=195).

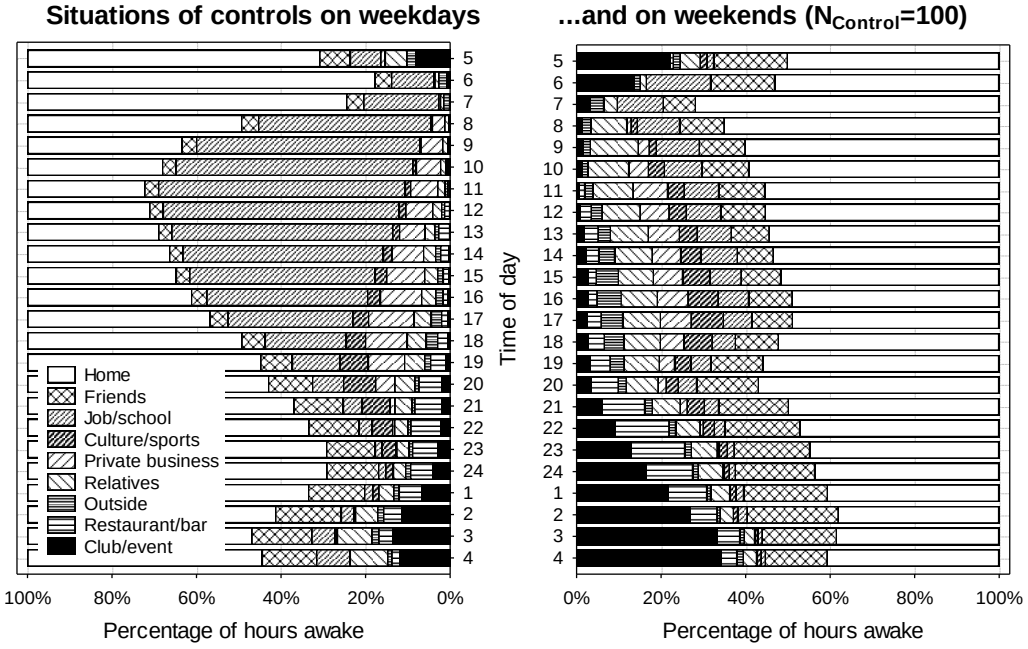


Figure 39: Proportion of time that was spent on different activities/at different localities for weekdays and weekends of controls ($N_{Control}$=100).

As one would expect, weekends and weekdays especially differ concerning work/school and going out in the evening (Figure 38). On weekends, users spent time at friends' all day long, whereas situations at friends' mostly occurred in the evening and at night on weekdays. Furthermore, users spent more time outside and at relatives' on weekends compared to weekdays and had more private business situations on weekdays compared to weekends (e.g. shopping, hair dresser, etc.).

The distribution of situations throughout the day of controls looks fairly similar to that of users (Figure 39). But in contrast to users, controls were more often out at public places on weekends (*restaurant/bar*, *club/event*), whereas users spent more time at friends' – on weekends the whole day, on weekdays especially at night. The only time when users were out more as compared to controls was between 6 and 8am on weekends. Additionally, controls seem to do more sports and cultural activities and had some more situations at relatives'.

14.5 Structure of consumption: drug incidences

14.5.1 Drug use as a function of time

Between 9pm and midnight, users consumed impairing substances in almost fifty percent of all hours (Figure 40). Later at night – until approximately 5am, the proportion of hours when the subjects were asleep increases. On days on which the subjects were still awake at that time, substance consumption again took place at around fifty percent of the time. Between 6am until noon, substance use occurred rather seldom.

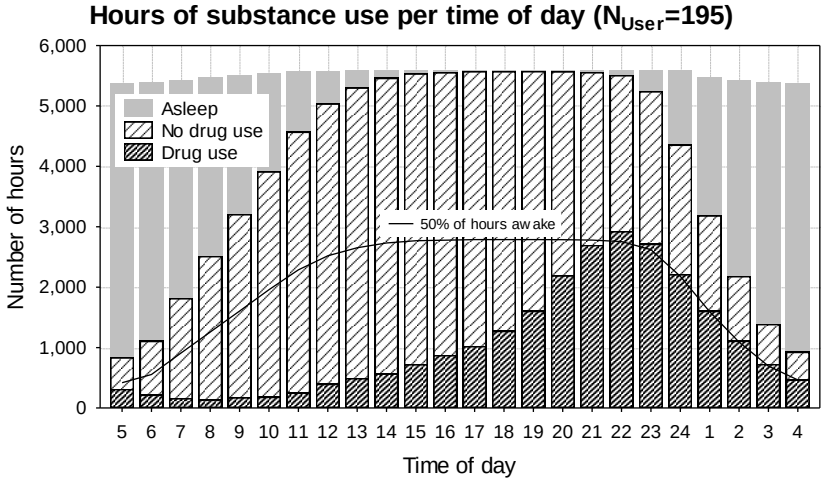


Figure 40: Hours of substance use per time of day (N_{User}=195).

The users spent much more time on consumption on weekends than on weekdays (Figure 41). In general, consumption continually increased from noon onwards with a peak between 9pm and midnight. From that time on until 4am on weekends, they spent up to 70% of the time while being awake on substance consumption, whereas

this was only true for approximately 40-50% of the time on weekdays. Additionally, consumption was still increased until around 6am on weekends, whereas it rather infrequently occurred in the early morning hours on weekdays. On weekends, they were less awake in the morning. So, the proportion of hours with substance consumption of all hours in which they were awake was rather high until 9am.

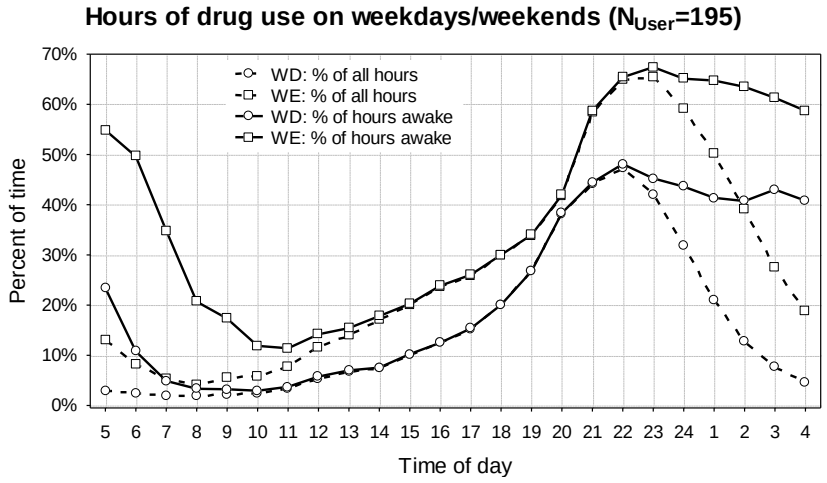


Figure 41: Hours of substance use (in % of all hours and % of hours awake) on weekdays and weekends (N_{User}=195).

When considering only those hours in which alcohol was consumed, it becomes obvious that the users spent more time on drinking than the controls, started drinking earlier in the day and drank more until the early-morning, especially on weekends (Figure 42). The same increase in consumption on weekends compared to weekdays is observable for the controls.

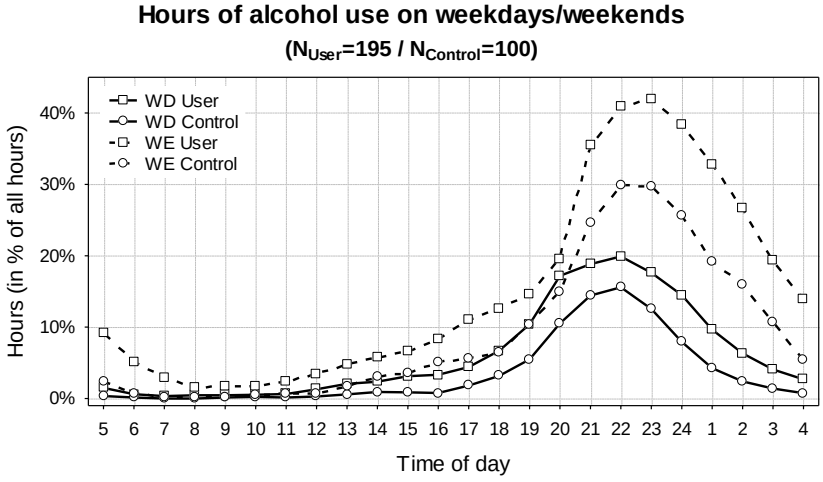


Figure 42: Hours of alcohol use (in % of all hours) on weekdays (WD) and weekends (WE) for users (N_{User}=195) and controls ($N_{Control}$=100).

In the following, all episodes with substance consumption were summarised into the categories *alcohol*, *cannabis*, *alcohol and cannabis* and *other drugs* (all stimulants, other drugs and drug combinations). The proportion of time spent on using the

different drugs is shown. Other drugs/drug combinations than cannabis and alcohol are more often used on weekends, namely from early afternoon on until early-morning (Figure 43). On weekends, the users also drank more alcohol than on weekdays. The proportion of alcohol consumption alone and alcohol consumption in combination with cannabis was higher throughout the day, except for the hours before and around noon. Consequently, the proportion of using cannabis alone is decreased on weekends compared to weekdays.

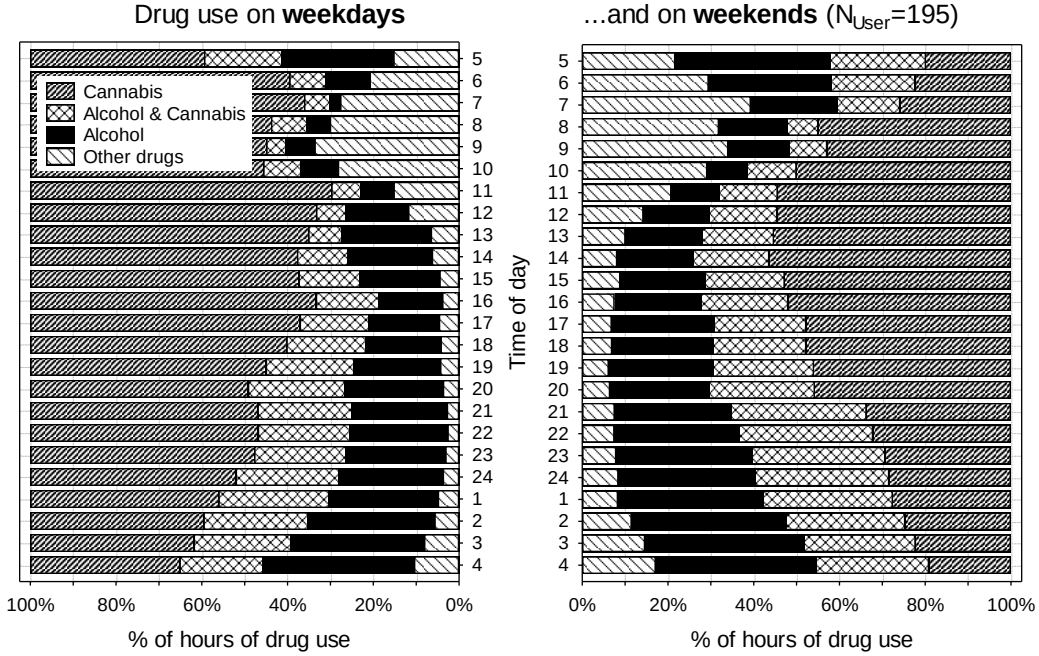


Figure 43: Proportion of time that was spent on the use of different drugs on weekdays and weekends (N_{User}=195).

14.5.2 Gender, age and residence

For all frequently used substances, three substance-specific parameters were calculated for each subject:

- **Drug days**: Number of days on which the subject was using the substance (extrapolated to 30 days[33])
- **Drug episode**: Mean number of drug using episodes per drug using day
- **Drug dose**: Mean drug dose per drug using episode[34]

Due to low prevalence rates within the sample, no specific parameters were calculated for the following substances (the number of subjects who used the drug at least once and the number of days on which they used it are specified in brackets):

[33] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of days with drug use divided by number of reported days and multiplied by 30).
[34] For alcohol, the dose per episode was reported in litres of beer, wine or liquor; for all other substances, the subjects reported the dose in the most common unit, i.e. joint, pipe, line, etc..

- **Psilocybin** (2 subjects on 1 day)
- **GHB** (2 subjects on 1 day)
- **Spice** (2 subjects on 1 day)
- **Heroin** (1 subject on 3 days)
- **Methadone/buprenorphine** (2 subjects on almost each day)
- **Salvia divinorum** (1 subject on 1 day)
- **Non-prescribed methylphenidate** (1 subject on 3 days)

94.9% of all users drank alcohol within the study period on about every third day (on 11.79 out of 30 days) (Table 23). In regards to the median, the users used cannabis on twice as many days as alcohol. Amphetamine was used by 24.6%, ecstasy and cocaine by 12-13% and LSD and sedatives by approximately 3% of all users. The number of consumption days ranges between one and three days out of 30 for these substances.

Table 23: Method of consumption, number of users (N_{User}=195) and controls ($N_{Control}$=100) who were using each drug at least once and number of days on which drug using subjects were using each drug (for all frequently used substances).

				Drug days (per person)					
Substance		**Method of consumption (% Units)**	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Alcohol	**User**	Beer (52%), wine (25%), liquor (23%)	**185 (94.9%)**	**11.79**	2.14	6.43	17.59	24.55	30
	Control	Beer (48%), wine (32%), liquor (20%)	**90 (90%)**	**8.13**	1.07	4.29	13.45	22.5	28.93
Cannabis		Joint (72%), pipe (27%), cookie/tea (,25%)	**195 (100%)**	**21**	5	13.45	27	30	
Amphetamine		Line (98%), pill (2%)	**48 (24.6%)**	**2.95**	1.03	1.62	5.69	11.61	19.29
Ecstasy		Pill (100%)	**26 (13.3%)**	**2**	1	1.07	2.73	5.81	6.43
Cocaine		Line (98%), inhalation (2%)	**23 (11.8%)**	**1.07**	.97	1.03	2.07	3.33	5.17
LSD		Blotter (100%)	**6 (3.1%)**	**1.05**	.91	.97	1.11	4.29	
Sedatives		Pill (100%)	**5 (2.6%)**	**1.94**	1	1.03	2.07	2.14	

Table 24: Number of drug using episodes per drug using day and dose per drug using episode for users (N_{User}=195) and controls ($N_{Control}$=100).

			Drug episodes (per day)						**Drug dose** (grams/units per episode[35])					
Substance		**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Alcohol	**User**	**185 (94.9%)**	**1.35**	1	1.17	1.67	2.17	2.75	**41.07**	18.93	29.26	55.21	82,74	149.33
	Control	**90 (90%)**	**1.17**	1	1	1.4	1.82	2.33	**31.07**	14	22	45.13	76.27	131.85
Cannabis		**195 (100%)**	**1.32**	1	1.13	1.6	2.38	3.28	**1.03**	.51	.73	1.53	2.58	4.49
Amphetamine		**48 (24.6%)**	**1.17**	1	1	1.5	2.2	2.5	**1.01**	.29	.50	1.65	2.75	3.04
Ecstasy		**26 (13.3%)**	**1**	1	1	1.17	2		**1**	.5	.67	1.5	2.06	3
Cocaine		**23 (11.8%)**	**1**	1	1	1.33	2		**1.17**	.2	.5	1.5	2.3	3
LSD		**6 (3.1%)**	**1**	1	1	1	1.25		**1**	.5	.5	1	1	
Sedatives		**5 (2.6%)**	**1**	1	1	1	1		**.75**	.5	.5	.75	1.5	

[35] Grams for alcohol; units for all other substances (joint/pipe/cookie/tea for cannabis, line/pill for amphetamine; pill for ecstasy; line/inhalation for cocaine; plotter for LSD; pill for sedatives).

Table 24 shows the number of episodes per day with substance consumption and the dose that has been consumed per drug episode. If users drank alcohol while participating in the study, they did it in about 1.35 episodes per day with a median dose of 41.07 gram alcohol (~2 beers). Around the same daily frequency accounts for cannabis (MD=1.32) with a dose of 1.03 joints (or pipes/cookies/teas) per drug episode. All other substances were used – if having been used at all – only once a day.

The alcohol-specific parameters were analysed for differences between users and controls. Because data distribution was not normal, rank order testing was applied (Mann-Whitney U-test). To analyse the number of days, all subjects who did not use alcohol were included in the analysis with a value of zero. All parameters were significantly different between users and controls. Users drank alcohol on more days (MWU: Z(1;295)=3.70; p=0.000), on more episodes per day (MWU: Z(1;275)=4.75; p=0.000) and in larger quantities (MWU: Z(1;275)=3.53; p=0.000).

The substance-specific parameters concerning alcohol (N_{User}=185), cannabis (N_{User}=195) and stimulants (N_{User}=65) were further analysed for differences between the different levels of the stratifying variables gender, age and residence. Again, rank order tests were applied (Kruskal Wallis H-Test and Mann-Whitney U-test). In the case that the independent variable had more than two levels, Kruskal Wallis H-Test were applied to test all levels. If the global result was significant or marginally significant, Mann-Whitney U-tests were applied afterwards to find out which levels differed significantly. To find out if interactions exist, a testing procedure was applied that was described by Conover and Iman (1981) and that was further developed by Thomas, Nelson and Thomas (1999). According to Conover and Iman (1981), non-parametric tests can be replaced by transforming the data into ranks. Then, the usual t-test or analysis of variance procedures can be applied. Thomas et al. (1999) suggest using the L-Statistic in this case, especially when more advanced parametric procedures are applied (i.e. factorial analysis of variance, multiple regressions)[36]. Whenever interactions are mentioned in the further course of this report, they were calculated according to this procedure. Table 25 shows all significant differences found for gender, age and residence concerning the use of alcohol, cannabis and stimulants. Here, only the users were analysed.

Males drank alcohol on more days and in a higher doses than females. They also used cannabis in higher doses, whereas the consumption frequency of cannabis (whether days or episodes per day are considered) does not differ between males and females. Females tend to use stimulants on more days than males. But this difference did not reach significance.

[36] L-Statistic – calculation:
L=(N-1) * r^2 (N=number of participants, r^2=proportion of true variance ($SS_{Between}/SS_{Total}$))
The L statistic is compared to a X^2 with pq degrees of freedom (df)
p=k-1 (k=number of groups)
q=number of dependent variables.

Age significant effects were found for alcohol episodes, alcohol dose and cannabis episodes. When 18-24-year-olds drank alcohol, if at all, they drank alcohol in more episodes per day compared to 30-39-year-olds. 18-24-year-olds also drank higher doses of alcohol compared to 25-29-year-olds and 30-39-year-olds (note that for the alcohol dose the interaction age*residence turned out to be positive; this is explained beneath Table 25). Both 18-24-year-olds and 25-29-year-olds used cannabis on more occasions per day than 30-39-year-olds.

Significant effects for residence were found for days of alcohol consumption, alcohol episodes, cannabis dose and stimulants dose. A significant trend was found for cannabis episodes (KW-H(2;195)=5.41; p=0.067). Subjects from urban and city areas drank alcohol on more days than subjects from rural areas. Subjects from urban areas drank in more episodes per day compared to subjects from city and rural areas. In contrast, subjects from rural areas consumed cannabis in higher doses and tend to consume cannabis more frequently per day than subjects from urban areas. Subjects from rural and city areas also used higher doses of stimulants compared to subjects from urban areas.

Table 25: Significant effects of gender, age and residence on substance-specific parameters for alcohol, cannabis and stimulants (N_{User}=195).

		Gender	Age	Residence
Alcohol	**Day**	male > female Z(1;195)=2.45; p=0.013		urban > rural Z(1;149)=2.59; p=0.010 city > rural Z(1;127)=2.26; p=0.024
	Episode		18-24 > 30-39 Z(1;135)=3.10; p=0.002	urban > rural Z(1;140)=2.24; p=0.025 urban > city Z(1;113)=2.36; p=0.019
	Dose	male > female Z(1;185)=5.66; p=0.000	18-24 > 25-29 Z(1;160)=4.04; p=0.000 18-24 > 30-39 Z(1;135)=3.44; p=0.001[1]	[1]
Cannabis	**Day**			
	Episode		18-24 > 30-39 Z(1;145)=2.83; p=0.005 25-29 > 30-39 Z(1;78)=1.99; p=0.047	(rural > urban Z(1;149)=1.99; p=0.047)
	Dose	male > female Z(1;195)=2.20; p=0.028		rural > urban Z(1;149)=2.47; p=0.013
Stimulants	**Day**	(female > male Z(1;195)=1.86; p=0.063)		
	Episode			
	Dose			rural > urban Z(1;51)=2.32; p=0.020 city > urban Z(1;39)=2.26; p=0.024

[1]sign. interaction age*residence (only sign. for subjects from rural/city areas): L(4;185)=9.74; p=0.045.

14.5.3 Consumption groups

14.5.3.1 Classification

For substances that were regularly used by the subjects while participating in the study, consumption classes were defined. According to Burger, Bronstrup and Pietrzik (2004), alcohol use can be differentiated into three classes depending on how much alcohol a person consumes per day. The suggested classification was used to classify the subjects of the present study into *moderate*, *heavy* and *excessive alcohol users* (Table 26).

Table 26: Classification of alcohol use into moderate, heavy and excessive alcohol use.

	Amount of alcohol consumed per day (grams)	
Classification	Male	Female
Moderate alcohol use	≤24 g/day	≤12 g/day
Heavy alcohol use	>24-60 g/day	>12-40 g/day
Excessive alcohol use	>60 g/day	>40 g/day

In the same way, it was attempted to find a mode for classifying cannabis use into different categories according to the amount of cannabis consumed. The Federal Highway Research Institute (Bundesanstalt für Straßenwesen - BASt) suggests to classify cannabis consumption of up to four times a week as occasional consumption and more than four times a week as heavy consumption (Müller et al., 2006). Because in the current survey a situation is always flanked by a previous and a subsequent trip, a consumption situation could be divided into two situations just because of a short trip in-between. Moreover, the persons surveyed in the present study were all regular users and consumed cannabis quite often. Most users would have been classified as heavy users according to the suggested classification. It was decided to classify cannabis consumption into *moderate*, *heavy* and *excessive use* as alcohol consumption according to the mean daily dose, quantified by the mean number of units that were consumed per day[37] (Table 27).

Table 27: Classification of cannabis use into moderate, heavy and excessive cannabis use.

Classification	**Amount of cannabis consumption per day (unit=joint, pipe, etc)**
Moderate cannabis use	<1 unit
Heavy cannabis use	1-<2 units
Excessive cannabis use	≥2 units

Stimulants (i.e. amphetamine, ecstasy, cocaine) were used by 65 subjects on one to 19 days within 30 days. Because of the low number of stimulant using subjects and the more infrequent stimulants use compared to alcohol and cannabis, it seemed reasonable to use the number of episodes a person used stimulants within the study period as classification criterion instead of units per day. If a person used stimulants up to once every two weeks, the person was classified as *moderate stimulants user*. If a person used stimulants on up to 1-2 occasions per week, the person was

[37] A unit is either a joint, a pipe, a cookie or cannabis consumed as tea.

classified as *heavy stimulants user*. If the consumption frequency was higher than 1-2 times per week, the person's stimulants use was classified as *excessive* (Table 28).

Table 28: Classification of stimulants use into moderate, heavy and excessive stimulants use.

Classification	Number of episodes within four weeks
Moderate stimulants use	≤2 episodes
Heavy stimulants use	≤6 episodes
Excessive stimulants use	>6 episodes

Table 29 shows the number of subjects within each category. 10 users (5.1%) and 10 controls (10%) did not use alcohol while participating. 41% of the users were moderate, another 41% heavy and the remaining 12.8% excessive alcohol users. Within the control group, the distribution of moderate, heavy and excessive users was 67%, 20% and 3%. In other words: there are 10% more excessive and 20% more heavy drinkers at the cost of 30% less moderate drinkers in the user group. Cannabis was consumed by all users. 53.8% were moderate, 23.1% heavy and another 23.1% excessive users. 13.3% of the users were moderate, 10.3% heavy and 9.7% excessive stimulant users.

Table 29: Number of subjects in each consumption category.

Classification		No consumption	Moderate	Heavy	Excessive
Alcohol use	**User**	10 (5,1%)	80 (41%)	80 (41%)	25 (12.8%)
	Control	10 (10%)	67 (67%)	20 (20%)	3 (3%)
Cannabis use		0	105 (53.8%)	45 (23.1%)	45 (23.1%)
Stimulants use		130 (66.7%)	26 (13.3%)	20 (10.3%)	19 (9.7%)

14.5.3.2 Comparison of daily alcohol dose with representative data

For the general German population, data about the percentage of persons who drink more than 12g (female) and more than 24g (male) alcohol per day, respectively, are available (Pabst & Kraus, 2006). 17.4% of the German population aged 18-64 belong to this category (Figure 44). Compared to the study sample that was aged 18-39, it gets obvious that the controls percentage resembles the one of the general population (control: 23%), whereas the percentage of the users is much higher (user: 53.8%).

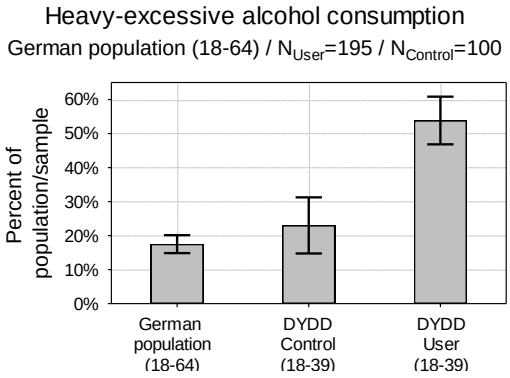


Figure 44: Percentage of heavy and excessive (females>12 g, males>24g per day) alcohol users within the German population (aged 18-64) and the study sample (N_{User}=195, $N_{Control}$=100) (±0.95 CI).

14.5.3.3 Problem awareness

To measure problem awareness concerning consumption, the subjects were asked how problematic they find their consumption behaviour for all substances they were currently using (Table 30).

Table 30: Q-Start question concerning problem awareness of own consumption.

Question
How problematic is your consumption in your opinion (concerning alcohol, cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin, sniffing agents, other substances)? 0=not at all, 1=very little, 2=little, 3=medium, 4=much, 5=very much

In general, the subjects never evaluated their consumption as highly problematic (Figure 45). The most evaluations ranged from *not at all* problematic to *medium* problematic. But the higher the consumption was (*moderate*, *heavy*, *excessive*), the more problematic the subjects evaluated it. This especially was true for alcohol. Moderate users of stimulants and cannabis classified their consumption pattern as more problematic than moderate alcohol users did.

The subjects' problem awareness rises as higher daily substance doses are consumed, but is relatively low when considering that excessive users who consume more than 60g alcohol (males) or 40g alcohol (females) per day, two or more joints per day or stimulants on more than 6 occasions per month think their consumption is only little to medium problematic.

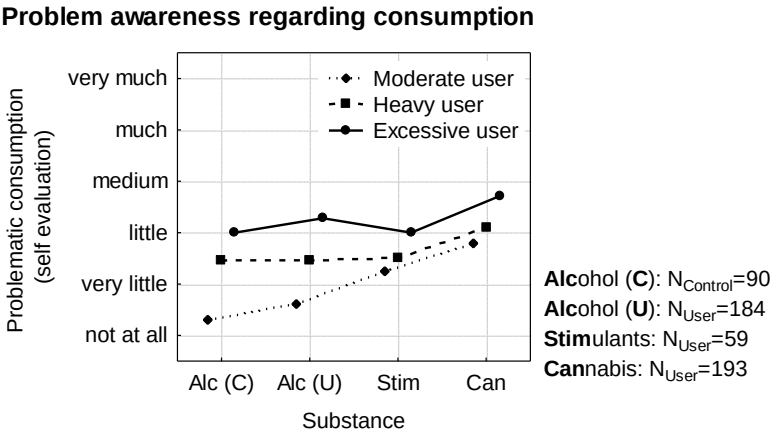


Figure 45: Problem awareness of own consumption (not at all, very little, little, medium, much, very much problematic), depending on consumption group (moderate, heavy, excessive user) and substance (alcohol, cannabis, stimulants)[38]*.*

[38] Because of missing data, the information about the subjective evaluation was not available for all users.

14.6 Trips

14.6.1 Mobility as a function of time

For the illustration of trips and drives in the course of the day and for comparing weekdays and weekends, the absolute number of trips/drives per hour and weekday/weekend day was divided by the absolute number of weekdays and weekend days, respectively, and distributed along the 24-hour timeline. So, the mean number of trips/drives is shown for each hour. The mean numbers of trips/drives for all 24 hours of a day add up to the mean number of trips/drives per day.

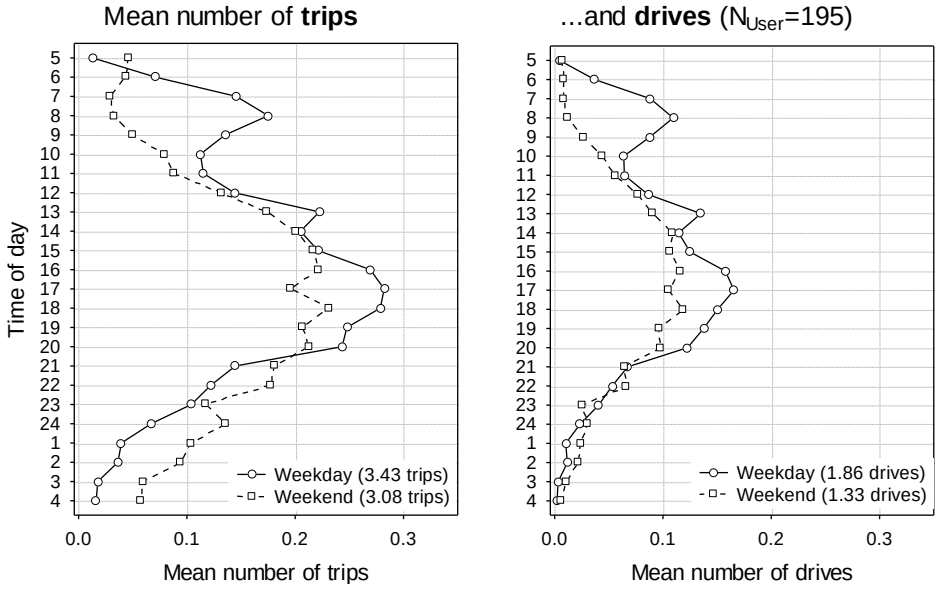


Figure 46: Mean number of trips and drives per time of day for users (N_{User}=195).

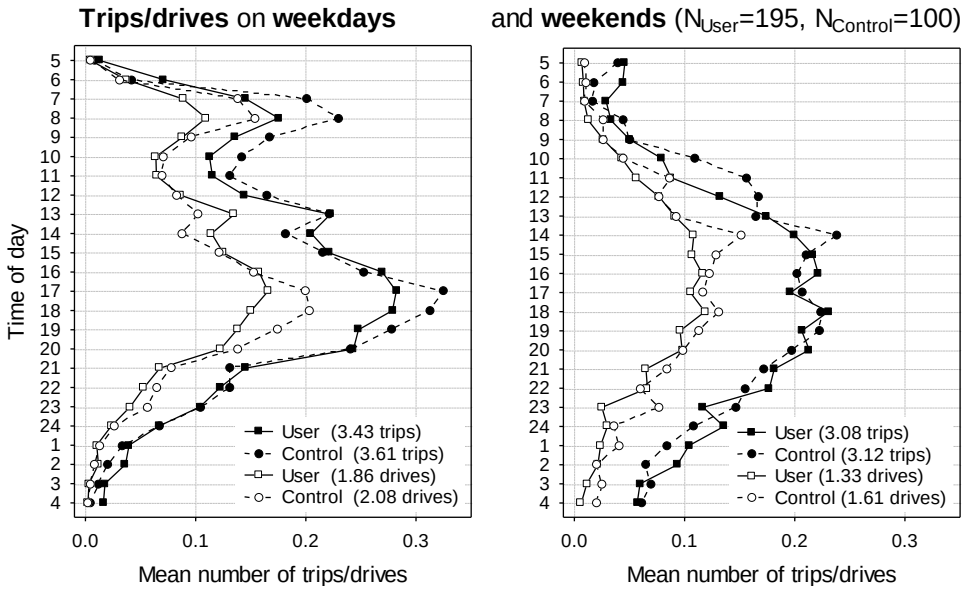


Figure 47: Mean number of trips/drives on weekdays and weekends for users (N_{User}=195) and controls ($N_{Control}$=100).

On weekdays, users had 3.43 trips per day on average and 3.08 on weekends (Figure 46). On weekdays, 1.86 (54.2%) of the trips were drives. On weekends, 1.33 (43.2%) of the trips were drives. On weekdays, mobility culminated at 7-9am, at noon and at 4-6pm – at times when the subjects had to go to and from work and school, respectively (Figure 46, left). In contrast, trips on weekends are distributed throughout the day. Compared to weekdays, weekend mobility was lower until 9pm. At night, the subjects were more mobile on weekends. The distribution of drives in the course of the day is very similar to the distribution of trips, except from the weekend night hours (Figure 46, right). Even if the subjects were out more on weekends at that time, they did not drive more. Instead, they must have used other modes of transport.

Both on weekdays and weekends, controls were more mobile in the morning and before and around noon compared to users, on weekdays also in the late afternoon (Figure 47). Users were more mobile at night and in the early-morning and on weekends also in the afternoon. On weekdays, controls drove more in the morning and in the evening – at usual rush-hour times. Users drove more at noon and had a less distinct peak in the morning and in the evening. On weekends, controls drove a little more throughout the day, even at night when users were generally more mobile. Considering the mobility on weekdays, controls seem to have a day structure that is more influenced by a usual daily working routine.

Figure 48 distributes the percentage of trips per time, travelled by the different transport modes and separated for weekdays and weekends (N_{User}=195). On weekdays, the subjects drove a vehicle and used public transport more often in the morning hours compared to weekends. The percentage of driving a vehicle alone was higher on weekdays. On weekends, the subjects were more often accompanied by others while driving or were passengers themselves. The rate of trips on foot or by bike is higher on weekday nights compared to weekends when the subjects took a taxi more often. In the early-morning, they especially travelled often by taxi on both weekdays and weekends.

Figure 49 shows the different modes of transport of controls. Users walked or used a bicycle more often at night compared to controls. Moreover, they travelled more often by taxi except for weekends at around 4-5am when controls used a taxi in around 20% of their trips. On weekdays in the morning, users used public transport more often than controls. On weekends, users travelled more by public transport than controls, independent of time of day. Obviously, there is a higher need or willingness among users to use taxis, public transport and/or walk or ride a bicycle. There is a clear difference concerning driving at night and, on weekends, also in the early morning hours. The controls often travelled as driver either alone or with companions, whereas users drove a vehicle less often at that time.

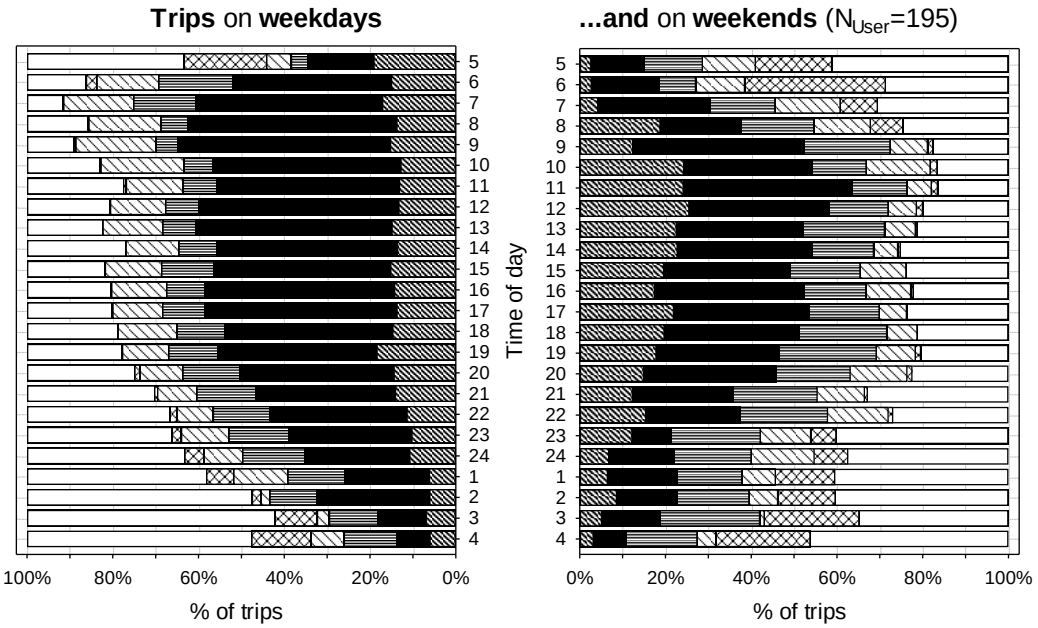


Figure 48: Proportion of modes of transport for users on weekdays and weekends (N_{User}=195).

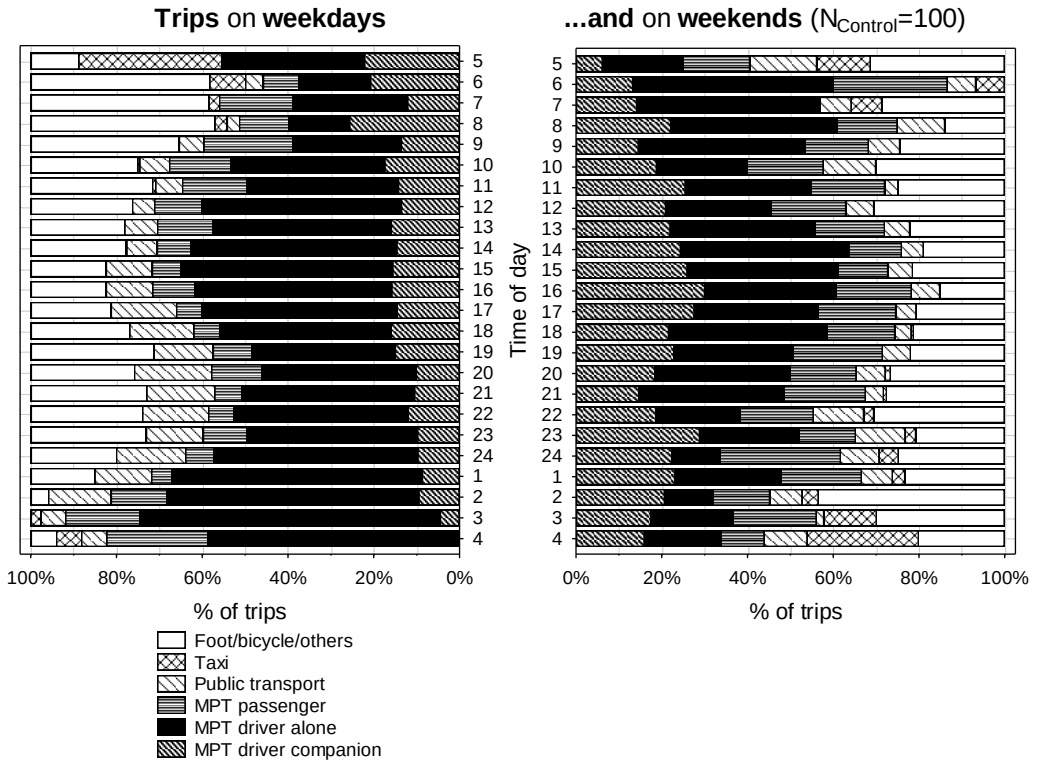


Figure 49: Proportion of modes of transport for controls on weekdays and weekends ($N_{Control}$=100).

14.6.2 Gender, age and residence

To better assess quantitative differences concerning the mobility of the subjects for all modes of transport, three trip-specific parameters were calculated for each subject:

- **Trip days**: Number of days on which the subject used the mode of transport (extrapolated to 30 days[39])
- **Trip**: Mean number of trips per trip day
- **Kilometres**: Mean kilometres per trip

The data had to be prepared beforehand concerning the following issues:

(1) If multiple modes of transport were named (e.g. on foot and public transport), the one that usually covers the farthest distance was declared as the main mode of transport (i.e. public transport in our example). The others were ignored. The adopted order was as follows:

foot
bicycle
taxi
public transport
moped
motorcycle
vehicle
transporter
truck

(2) In the second step, the categories were further summarised to the categories ***foot/bicycle/other***[40], ***taxi***, ***public transport***, motorised private transport as passenger (***MPT passenger***) and motorised private transport as driver (***MPT driver***)

(3) Because the subjects indicated the kilometres of a trip through the categories *<1 km*, *1-5 km*, *5-10 km*, *10-25 km*, *25-100 km* and *> 100 km*, the categories had to be transformed into interval-scaled data for further analyses. Representative German data (MiD 2008) were used to calculate the median of kilometres within each category (for the 18-39-year-old population). This resulted in the following values:

<1 km	→	MD 0.95 km
1-5 km	→	MD 2.85 km
5-10 km	→	MD 7.6 km
10-25 km	→	MD 15.2 km
25-100 km	→	MD 37.05 km
>100 km	→	MD 162.45 km

All users drove a vehicle as a driver (MPT driver) at regular intervals (MD 20 out of 30 days) (Table 31). 97.4% of the users travelled by foot or by bike on every third day. 92.8% of the users were passenger while participating in the study and 78.5%

[39] Because of the varying number of available reports per person (number of mobile days divided by number of reported days and multiplied with 30).
[40] Other: Boat, ambulance and tractor – N=3.

used public transport. Only around half of the users took a taxi within the 4-week study period.

Table 31: Mode of transport, number of users (N_{User}=195) who chose each mode at least once and number of days those subjects used each mode.

		Trip days (per person)					
Mode of transport	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Foot/bicycle/other	**190 (97.4%)**	**9.84**	1.07	4.29	16.55	24.64	30
Taxi	**99 (50.8%)**	**1.3**	1	1.07	3.1	5.36	8.28
Public transport	**153 (78.5%)**	**5.36**	1	2.14	11.79	23	27.93
MPT passenger	**181 (92.8%)**	**6**	1.07	3.21	9.64	18.21	26.79
MPT driver	**195 (100%)**	**20**	9	14.48	24.64	28.06	30

Table 32 shows the number of trips per day and the kilometres per trip for each particular mode of transport. If someone used a taxi for transport, this was only done for one direction in most of the cases. All other modes of transport were used approximately twice a day. The farthest distances were travelled by vehicles followed by public transport and taxis. The shortest distances were covered by foot or bike.

Table 32: Number of trips per trip day and number of kilometres per trip of users (N_{User}=195).

		Trips (per day)						**Kilometres** (per trip)					
Transport	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Foot/bicycle/other	**190 (97.4%)**	**1.91**	1	1.5	2.26	2.79	3.73	**2.07**	.95	1.33	2.82	4.65	15.2
Taxi	**99 (50.8%)**	**1**	1	1	2	2	30	**6.18**	2.85	2.85	7.6	15.2	37.05
Public transport	**153 (78.5%)**	**1.67**	1	1.25	2	2.5	3.21	**7.6**	2.85	3.8	15.2	61.75	162.45
MPT passenger	**181 (92.8%)**	**1.71**	1	1.4	2	2.45	3.11	**11.46**	2.85	6.75	19.95	57.54	162.45
MPT driver	**195 (100%)**	**2.43**	1.74	2.12	2.94	3.81	4.80	**11.53**	3.73	7.93	18.12	30.95	65.78

The trip-specific parameters were analysed for differences between users (N_{User}=195) and controls ($N_{Controls}$=100) (Table 33 and Table 34). The data were analysed by rank order testing (Mann-Whitney U-test). For the analysis of the number of days, all subjects who did not use the mode of transport in question were included in the analysis with a value of zero. Users took a taxi more often than controls. They used it on more days (MWU: Z(1;295)=4.47; p=0.000) as well as on more occasions a day (MWU: Z(1;123)=2.08; p=0.038). On the other hand, controls drove a vehicle on more days compared to users (MWU: Z(1;295)=2.35; p=0.019).

Table 33: Mode of transport, number of controls ($N_{Controls}$=100) that chose each mode at least once and number of days those subjects used each mode.

		Trip days (per trip person)					
Transport	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Foot/bicycle/other	**93 (93%)**	**9.73**	1.07	3.21	15.52	24.64	26.9
Taxi	**24 (24%)**	**1.07**	1	1.03	2.14	7.5	8.57
Public transport	**72 (72%)**	**5.78**	1.03	2.62	12.38	19.66	23.79
MPT passenger	**89 (89%)**	**6.21**	1.07	3.21	9.23	16.55	22.94
MPT driver	**100 (100%)**	**22.36**	9.99	17.5	25.71	28.56	30

Table 34: Number of trips per trip day and number of kilometres per trip for controls ($N_{Controls}$=100).

		Trips (per day)						**Kilometres** (per trip)					
Transport	**$N_{subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
Foot/bicycle/other	**93 (93%)**	**1.86**	1	1.5	2.25	3.52	4.36	**1.96**	0.95	1.33	2.85	6.36	17.48
Taxi	**24 (24%)**	**1**	1	1	1.31	1.63	2	**2.85**	2.85	2.85	8.08	29.77	37.05
Public transport	**72 (72%)**	**1.82**	1	1.5	2.06	2.5	3	**7.6**	2.85	2.85	15.2	82.41	162.45
MPT passenger	**89 (89%)**	**1.8**	1	1.5	2	2.4	3	**10.68**	2.85	6.65	21.82	56.19	162.45
MPT driver	**100 (100%)**	**2.55**	1.82	2.25	2.96	4.02	4.43	**12.66**	4.58	9.37	17.16	32.34	63.11

Furthermore, the different levels of the stratifying variables were analysed for differences in the trip-specific parameters. To be able to indentify interactions between the main factors gender, age and residence, the same procedure as described in Chapter 14.5.2 was applied.

Table 35: Significant effects of gender, age and residence on trip-specific parameters (N_{User}=195).

		Gender	**Age**	**Residence**
Foot/bicycle/other	**Day**			urban > city Z(1;114)=3.83; p=0.000
	Situation			urban > city Z(1;112)=3.91; p=0.000
	Km	male > female Z(1;190)=3.21; p=0.001	[1]	[1]
Taxi	**Day**			urban > rural Z(1;149)=2.30; p=0.022 city > rural Z(1;127)=2.81; p=0.005
	Situation			
	Km			rural > urban Z(1;71)=3.14; p=0.002 city > urban Z(1;67)=2.54; p=0.011
Public transport	**Day**		18-24 > 25-29 Z(1;167)=2.85; p=0.004 18-24 > 30-39 Z(1;145)=3.72; p=0.000	city > rural Z(1;127)=5.94; p=0.000 urban > rural Z(1;149)=2.96; p=0.003
	Situation			city > rural Z(1;99)=3.37; p=0.000 city > urban Z(1;98)=2.73; p=0.006
	Km			rural > urban Z(1;109)=6.31; p=0.000 city > urban Z(1;98)=5.15; p=0.000
MPT passenger	**Day**	female > male Z(1;195)=2.21; p=0.027[2]	18-24 > 25-29 Z(1;167)=3.51; p=0.000 18-24 > 30-39 Z(1;145)=3.94; p=0.000[2]	rural > city Z(1;127)=3.46; p=0.000 urban > city Z(1;114)=2.94; p=0.003[2]
	Situation	female > male Z(1;181)=2.66; p=0.008[3]	[3] [4]	rural > city Z(1;117)=3.25; p=0.001 urban > city Z(1;107)=2.80; p=0.005[4]
	Km			

		Gender	Age	Residence
MPT driver	**Day**		30-39 > 18-24 Z(1;145)=2.59; p=0.010	rural > urban Z(1;149)=1.99; p=0.047 rural > city Z(1;127)=2.24; p=0.025
	Situation			rural > city Z(1;127)=2.78; p=0.005
	Km	[5]	[5]	rural > urban Z(1;149)=2.02; p=0.043 city > urban Z(1;114)=2.44; p=0.015

[1]sign. interaction age*residence (18-24-year-olds in urban/city areas farther distances than in rural areas; in rural areas 30-39-year-olds farther distances than 18-24-year-olds): L(4;190)=11.04; p=0.026.
[2]sign. interaction gender*age*residence: L(4;195)=11.54; p=0.021.
[3]sign. interaction gender*age (only for 18-24- and 30-39-year-olds sign): L(2;181)=7.94; p=0.019.
[4]sign. interaction age*residence (only for 18-24-year-olds sign): L(4;181)=13.09; p=0.011.
[5]sign. interaction gender*age (males farther distances at age 25-39 than at age 18-24): L(4;195)=7.73; p=0.021.

Males travelled longer distances on foot/by bike than females (Table 35). Females were more often passengers than males. The latter is also true for 18-24-year-olds compared to 25-29- and 30-39-year-olds. The younger subjects also travelled more by public transport, whereas the 30-39-year-olds drove a vehicle more often than the 18-24-year-olds did. As one would expect, the main differences were found between rural, urban and city areas. Subjects from urban areas travelled on foot/by bike on more days and more often a day than subjects from city areas. Travelling by taxi was more prevalent in city/urban areas, but the distances covered were farther in rural and city areas compared to urban areas. Public transport was mostly used in city and – in relation to the number of days – in urban areas, but here again the farthest distances were covered in rural and city areas compared to urban areas. Passengers were more found in rural and urban areas compared to city areas. Subjects from rural areas were most often drivers of a vehicle and had to cover, together with subjects from city areas, the farthest distances when driving a vehicle. Significant interactions are explained beneath the table.

14.6.3 Driving groups

As for consumption (Chapter 14.5.3), the subjects were categorised according to their driving frequency to be able to analyse the impact of driving on the occurrence of driving under influence. To classify the driving frequency, the same categories as they are used in a national Germany survey about mobility were applied (MID 2008): *daily or almost daily*, *on 1-3 days a week*, *on 1-3 days a month*, *less than monthly* and *never or almost never*. In the present study, only regular drivers were admitted. So, only the first two categories were applied (*daily driving*, *weekly driving*) (Table 36).

Table 36: Classification of driving into weekly and (almost) daily driving and number of users (N_{User}=195) and controls ($N_{Control}$=100) within each category.

Classification	Frequency of driving per week (in days)	N_{User}=195	$N_{Control}$=100
Weekly driving	1-3 days per week	76 (39%)	22 (22%)
(Almost) Daily driving	≥4 days per week	119 (61%)	78 (78%)

Within the user group, 39% drove weekly while participating in the study and 61% drove daily. Within the control group, 22% were weekly drivers and 78% daily drivers.

14.7 Prevalence of DUI

14.7.1 Definition of DUI

To decide on whether a drive was conducted under influence, different approaches for the different substances were chosen. For alcohol and cannabis, the calculated BAC- and THC-level at the beginning or at the end of a drive was used, depending on which one was higher (Chapter 13). According to the elimination curve by Sticht, the concentration of THC in blood converges to zero after six hours after smoking a joint that contains 15 mg THC (G. Sticht, personal communication, December 2009). Because of the cannabis-like effects of spice and because no reliable information is known about the duration of the effect of spice, a drive was classified as under influence if it occurred six hours after spice consumption. For the remaining substances, the doubled half-life of each substance was applied (adjusted upward; provided by Schulz & Schmoldt, 2003; Passie, Seifert, Schneider, & Emrich, 2002; Prisinzano, 2005)[41]. The rules to define a drive as an intoxicated drive are listed in Table 37.

Table 37: Basis for the definition of DUI.

	Basis of decision	**Calculated blood concentration**
Alcohol	Widmark Formula (Widmark, 1932)	BAC≥0.01%
Cannabis	Elimination curve by Sticht (G. Sticht, personal communication, December 2009)	THC blood plasma level≥1ng/ml
	Source	**Previous drug use within**
Amphetamine	Schulz & Schmoldt (2003)	16 hours
Ecstasy	Schulz & Schmoldt (2003)	20 hours
Cocaine	Schulz & Schmoldt (2003)	2 hours
LSD	Schulz & Schmoldt (2003)	10 hours
Heroin	Schulz & Schmoldt (2003)	8 hours
Psilocybin	Passie et al. (2002)	8 hours
GHB	Schulz & Schmoldt (2003)	2 hours
Spice	deduced from elimination curve of cannabis	6 hours
Salvia Divinorum	Prisinzano (2005)	4 hours

14.7.2 Frequency of DUI within the study sample

Averaged per person, 20.5% of the users' drives (N_{User}=195) were classified as drug positive, independent of what drug and what concentration is considered. When considering only drives with a BAC of 0.05% and higher, a THC blood plasma level of

[41] Substances that primarily serve as medicines are not considered at this point: one person misused methylphenidate (three episodes) and five persons used sedatives (eight episodes). In all but two cases the subjects did not drive within at least twelve hours after the intake.

4ng/ml and higher[42], and/or drives positive for any other drugs, the mean percentage of drives under influence within the user sample drops by around 40% from previously 20.5% to 13.1%. The only drive that was positive for spice was also positive for cannabis. The psychoactive effects of both drugs are very similar. So, the drive was classified as a cannabis-positive drive only. No drive that was found to be positive for LSD, psilocybin, GHB and salvia divinorum was identified.

Table 38: Number of drives and percentage of all drives under influence within the user group, mean percentage and ±0.95 CI by person (N_{User}=195)[43].

		Total sample	By person
		Number of drives (%)	Mean % of drives (±0.95 CI)
All drives		9,553 (100%)	
	Sober	7,454 (78%)	
	Under influence	2,099 (22%)	20.5% (17.4% - 23.5%)
Not separated for single-/poly-drug drives (multiple specifications possible)			
	Cannabis	1,521 (15.9%)	14.8% (11.8% - 17.7%)
	Alcohol	546 (5.7%)	5.4% (4.2% - 6.7%)
	Stimulants	223 (2.3%)	2.2% (1.1% - 3.4%)
	Amphetamine. XTC. Amphetamine and XTC. Cocaine	186 (1.9%). 17 (0.2%). 19 (0.2%). 1 (0.01%)	1.8% (0.8% - 2.9%). 0.2% (0.1% - 0.3%). 0.2% (-). 0.01% (-)
	Heroin	5 (0.05%)	0.05% (-)
Separated for single-/poly-drug drives			
Single drug	**Cannabis**	1,354 (14.2%)	13.1% (10.5% - 15.8%)
	Alcohol	410 (4.3%)	4.1% (3% - 5.1%)
	Stimulants	147 (1.5%)	1.5% (0.5% - 2.4%)
Multiple drugs	**Total**	188 (2%)	1.8% (1.1% - 2.5%)
	Cannabis / Alcohol	107 (1.1%)	1% (0.5% - 1.5%)
	Cannabis / Stimulants	47 (0.5%)	0.4% (0.1% - 0.8%)
	Alcohol / Stimulants	21 (0.2%)	0.2% (0.1% - 0.3%)
	Cannabis / Alcohol / Stimulants	8 (0.1%)	0.1% (-)
	Cannabis / Heroin	5 (0.05%)	0.05% (-)

The mean percentage of drives under the influence of cannabis was 14.8%. The mean percentage of alcohol-positive drives was 5.4%. On average, 2.2% of the users' drives were under the influence of stimulants (amphetamine: 1.8%, ecstasy: 0.2%, amphetamine and ecstasy: 0.2%, cocaine: 0.01%) and 0.05% under the influence of heroin (Table 38). The mean percentage of drives under the influence of cannabis alone was 13.1%. On average, 4.1% of the users' drives were under the influence of alcohol alone and 1.5% under the influence of stimulants alone. The remaining 1.8% drug-positive drives were positive for multiple drugs of which the greatest part was under the influence of alcohol and cannabis (1%). Figure 50 shows the mean percentage of BAC-/THC-positive drives for different BACs and THC blood

[42] According to Berghaus, Sticht and Grellner (2011) a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.
[43] Confidence intervals for the mean percentage of DUI were only calculated for those DUI categories that were committed by a sufficient large number of subjects (for a detailed description of the calculation see Chapter 14.7.3).

plasma levels. For alcohol, the controls' positive drives are also shown. The mean percentage of the controls' BAC-positive drives amounts to a total of 2.2%, i.e. less than half of the users' BAC-positive drives (5.4%).

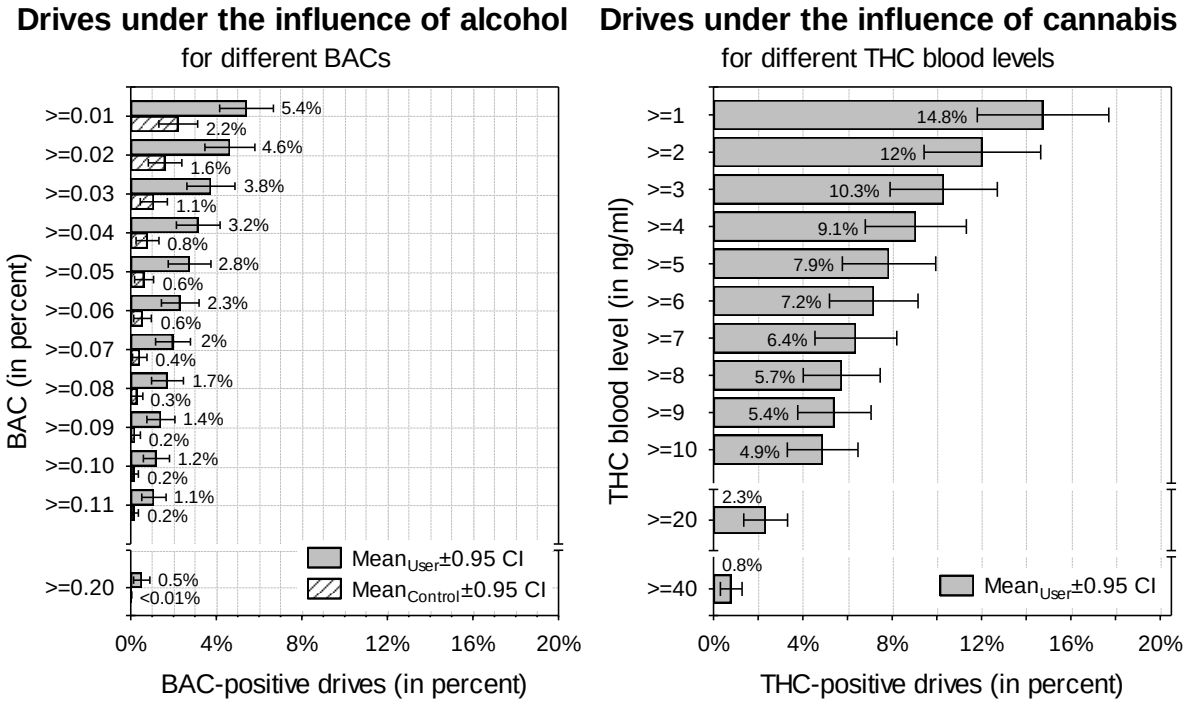


Figure 50: Mean percentage of drives (±0.95 CI) under the influence of alcohol (left) and cannabis (right) of users (N_{User}=195) and in the case of BAC-positive drives of users (N_{User}=195) and controls ($N_{Control}$=100) for different BACs and THC-levels (accumulated).

To better assess quantitative differences concerning driving after alcohol, cannabis and stimulants consumption, three specific parameters were calculated for each subject:

- **DUI days**: Number of days on which the subject drove after alcohol, cannabis and stimulants consumption (extrapolated to 30 days[44])
- **DUI**: Mean number of DUI per DUI day
- **Kilometres**: Mean kilometres per DUI[45]

In general, 59% of the users drove with a positive BAC. Drives with BACs of 0.05% and higher were committed by 35.9% of the users. 65.6% of all users drove with a positive THC blood plasma level (51.3% with a THC blood plasma level of ≥4ng/ml). 17.4% of the users drove after consuming stimulants (Table 39). Whereas users drove on average (median) on 2 days within a 30-day period with a positive BAC,

[44] Because of the varying number of available reports per person, the days were extrapolated to 30 days (number of drug driving days divided by number of reported days and multiplied by 30).
[45] The calculation was already explained in Chapter 14.6.2.

they drove on 4 days with a positive THC level. The number of days with drives under alcohol or THC seems to be hardly moderated by the substance concentration.

Table 39: Number of users (N_{User}=195) who drove under influence of alcohol, cannabis and stimulants and number of days they drove under the influence of each substance.

			DUI days (per DUI person)					
DUI substance		**N_{User}**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
BAC	**≥0.01%**	**115 (59%)**	**2.14**	1	1.07	5.36	10.71	23.79
	≥0.05%	**70 (35.9%)**	**1.91**	0.91	1.07	3	8.18	17.59
THC	**≥1ng/ml**	**128 (65.6%)**	**4.29**	1	2.11	9.31	22.50	26.79
	≥4ng/ml	**100 (51.3%)**	**4.21**	1	1.91	8.28	17.59	23.57
Stimulants		**34 (17.4%)**	**1.88**	0.91	1.03	4.62	16.07	21.43

Table 40 illustrates the number of DUI per DUI day and the kilometres per drive. If someone drove with a positive BAC, in most of the cases, this was only done once a day. In most of the cases, THC-positive drives occurred on one to two occasions per day. Drives after consumption of stimulants happened approximately once a day. No difference is observable for the number of kilometres between lower and higher BAC and THC blood plasma levels and between alcohol, cannabis and stimulants.

Table 40: Number of DUI per DUI day and number of kilometres per DUI for users (N_{User}=195).

			DUI (per DUI day)						**Kilometres** (per DUI)					
DUI substance		**N_{User}**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**Max**
BAC	**≥0.01%**	**115 (59%)**	1	1	1	1.5	2.29	3	9.03	2.85	4.43	15.2	37.05	162.45
	≥0.05%	**70 (35.9%)**	1.06	1	1	1.65	3	3	10	2.22	5.23	15.2	67.64	162.45
THC	**≥1ng/ml**	**128 (65.6%)**	1.5	1	1	1.86	2.5	3.18	8.91	2.47	3.80	15.2	42.75	88.83
	≥4ng/ml	**100 (51.3%)**	1.19	1	1	1.78	2.1	3	8.21	2.3	3.59	15.2	60.48	162.45
Stimulants		**34 (17.4%)**	1.38	1	1	2	3	3.7	7.6	2.85	2.85	15.2	54.96	162.45

The parameters for BAC-positive drives with BACs≥0.01% and BACs≥0.05% were analysed for differences between users (N_{User}=195) and controls ($N_{Controls}$=100, Table 41). The data were analysed by rank order testing (Mann-Whitney U-test). For the analysis of the number of DUI days, all subjects who did not drive under influence of alcohol were included in the analysis with a value of zero.

Table 41: Number of controls ($N_{Control}$=100) who drove under influence of alcohol, number of days on which they drove under influence of alcohol, number of BAC-positive drives per day and number of kilometres per BAC-positive drive.

		$N_{Control}$	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
BAC≥0.01%	**DUI days** (per DUI person)	**39 (39%)**	1.07	0.88	1.03	4.29	7.5	11.38
	DUI (per DUI day)		1	1	1	1.33	2	2
	Kilometres (per DUI)		7.6	2.22	2.85	17.58	162.45	162.45
BAC≥0.05%	**DUI days** (per DUI person)	**15 (15%)**	1.07	0.88	1.03	2.14	9.31	9.31
	DUI (per DUI day)		1	1	1	1.33	3	3
	Kilometres (per DUI)		15.2	2.85	7.6	37.05	162.45	162.45

The users drove with a positive BAC on more days than the controls, regardless whether a BAC of 0.01% or higher or a BAC of 0.05% or higher was considered (BAC≥0.01%: MWU: Z(1;295)=3.69; p=0.000; BAC≥0.05%: MWU: Z(1;295)=3.87; p=0.000). The samples did not differ in the number of BAC-positive drives per day nor in the number of kilometres per BAC-positive drive.

14.7.3 Calculation of confidence intervals

Before analysing the frequency of drug driving, several considerations were taken into account. The present study design was chosen to draw conclusions about the prevalence of drug driving and at the same time about the drug driver in general. Data were collected from 195 drug users (inter-individual variance), who were observed for 28 days (intra-individual variance). As a consequence, the study design poses the problem of combining intra- and inter-individual variance in a meaningful way, depending on which question was answered.

For the estimation of the general prevalence of drug driving, the percentage of drives under influence of all drives within the sample could be used as basic population when calculating confidence intervals (CI for percent values; Table 42). In doing so, the fact that all users' drives (N_{Drive}=9,553) were travelled by a comparatively small number of persons (N_{User}=195) would be disregarded and intra-individual variance would be treated as inter-individual variance. The huge number of drives that would be used as basic population would bring about unrealistic small confidence intervals:

Percentage of THC-positive drives of all users' drives within the sample:
15.9%; CI: 15.2% - 16.6%).

For other questions, the driver himself is of interest. How high is the percentage of drug users who drive after the consumption of drugs? By pursuing this person-related approach, the inter-individual variance is of interest and, so, the use of the number of drivers as basic population is mandatory:

Percentage of drug users who drove after cannabis consumption while participating
65.6%; CI: 59% - 72.3%

To extrapolate the occurrence of drug driving into representative figures, eventually, a combination of the two approaches was used to avoid the above mentioned problem: First, the percentage of drives under influence on all drives was calculated for every person. Second, these values were averaged over all persons. This calculated sample mean was then extrapolated into a prevalence rate of the general German driver population (calculation see Chapter 14.7.4). The confidence interval for the sample mean was calculated by the number of persons (N_{User}=195) as the basic population (CI for mean values; Table 42). So, the fact that the sample is relatively small was considered and influenced the size of the calculated confidence intervals:

Mean percentage of THC-positive drives of all drives per subject
14.8%; 11.8% - 17.7%

Table 42: Formulas to calculate confidence intervals (for percent values and for mean values; Bortz, 2010).

	Percent values	Mean values
SE (standard error)	$\hat{\sigma}_{Percent\ values} = \sqrt{\frac{p\ *\ (1-\ p)}{n}}$	$\hat{\sigma}_{Mean} = \frac{\hat{\sigma}}{\sqrt{n}}$
CI (confidence interval)	$p - z_{(\frac{\alpha}{2})} * SE;\ p + z_{(\frac{\alpha}{2})} * SE$	$\bar{x} - z_{(\frac{\alpha}{2})} * SE;\ \bar{x} + z_{(\frac{\alpha}{2})} * SE$

14.7.4 Extrapolation into representative features

To estimate the proportion of BAC-/THC-positive drives in the population by the survey results, the proportion of drives of the population that is represented by the sample on all drives was calculated according to the following procedure[46]:

(1) From existing mobility measures (Mobility in Germany 2008 – MiD 2008), the proportion of drives that were travelled by 18-39-year-olds who regularly drive (i.e. (almost) daily/weekly) was calculated:

18-39-year-old population of regular drivers – proportion of all drives:
32.9% (18-24-year-olds: 6.3% / 25-39-year-olds: 26.6%)

(2) From existing drug prevalence data (Epidemiological Survey on Substance Abuse 2006 – ESA 2006), the prevalence for regular drug use (i.e. more than three times in four weeks) for the 18-39-year-old population was calculated:

Prevalence for regular drug use for 18-39-year-old population:
2.8% (18-24-year-olds: 4.8% / 25-39-year-olds: 2.1%)

(3) The proportion of drives that were travelled by 18-39-year-olds who regularly drive and regularly use drugs (=*sample like population*) can be calculated as follows:

Sample-like population's proportion of all drives:
2.8%*32.9%/100=**0.92%**

By assuming the proportion of the sample-like population's drives to be 0.92% (±0.95 CI[47]: 0.73% - 1.12%) of all drives and by assuming that 39-year-olds and older do not drive after cannabis consumption (because the drug prevalence rate in this age

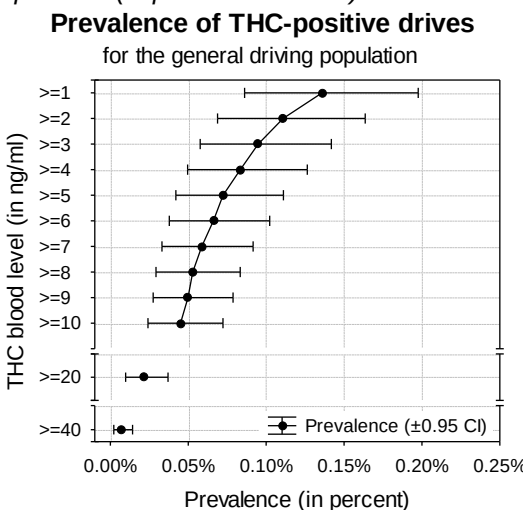
[46] It has to be kept in mind that, even if the sample was selected with caution and resembles the general population in a satisfactory manner, the extrapolated prevalence rates have to be interpreted with care. To show the uncertainty that underlies the prevalence rates calculated by the data of the study sample, confidence intervals are provided (see also Chapter 14.7.3).

[47] Calculated by multiplying the lower and upper limits of the confidence intervals of the proportion of the 18-39-year-old population of regular drivers of all drives (±0.95 CI: 32.5% - 33.3%; MiD 2008) with the prevalence for regular drug use within the 18-39-year-old population (±0.95 CI: 2.2% - 3.4%; ESA 2006). This calculation results in asymmetric intervals.

group is very low[48], the prevalence of THC-positive drives in the German driver population can be calculated by simply multiplying the mean percentage of THC-positive drives within the sample with 0.92 and divide it by 100. This results in the following prevalence rates for THC (Table 43).

Table 43: Mean percentage of drives under the influence of cannabis within the sample and prevalence rates of THC-positive drives estimated for the population (in percent ±0.95 CI).

THC blood plasma level (in ng/ml)	**THC-prevalence$_{Sample}$** (Mean$_{Sample}$±0.95 CI)	**THC-prevalence** (Prevalence±0.95 CI)
≥1	14.8% (11.8 - 17.7%)	0.14% (0.09 - 0.2%)
≥2	12% (9.4 - 14.7%)	0.11% (0.07 - 0.16%)
≥3	10.3% (7.9 - 12.7%)	0.09% (0.06 - 0.14%)
≥4	9.1% (6.8 - 11.3%)	0.08% (0.05 - 0.13%)
≥5	7.9% (5.8 - 10%)	0.07% (0.04 - 0.11%)
≥6	7.2% (5.2 - 9.2%)	0.07% (0.04 - 0.1%)
≥7	6.4% (4.5 - 8.2%)	0.06% (0.03 - 0.09%)
≥8	5.7% (4 - 7.5%)	0.05% (0.03 - 0.08%)
≥9	5.4% (3.8 - 7.1%)	0.05% (0.03 - 0.08%)
≥10	4.9% (3.3 - 6.5%)	0.05% (0.02 - 0.07%)
≥20	2.3% (1.4 - 3.3%)	0.02% (0.01 - 0.04%)
≥40	0.8% (0.3 - 1.3%)	0.01% (0 - 0.01%)



The same procedure can be applied to calculate the prevalence of stimulants-positive drives, drives under the influence of multiple drugs and drives under the influence of alcohol in combination with an illegal drug. For drives under the influence of stimulants (cocaine in- or excluded), the prevalence turned out to be 0.02% (95% CI: 0.01% - 0.04%). For drives under the influence of multiple drugs (any drug combination, alcohol included), the prevalence is 0.02% (95% CI: 0.01% - 0.03%) and for drives under the influence of alcohol in combination with an illegal drug, the prevalence is 0.01% (95% CI: 0.006% - 0.02%).

For BAC-positive drives, no information is given about the prevalence of BAC-positive drives within the population above 39-year-olds. The high proportion of all drives (MiD 2008)[49] and the high prevalence of risky alcohol consumption in this age group (ESA 2006)[50] led to the suspicion that the prevalence of BAC-positive drives is rather high within this age category. Thus, for BAC-positive drives the further analysis is reduced to the calculation of the prevalence rate within the 18-24- and the 25-39-year-old sub-population.

Figure 51 and Table 44 show the mean percentage of BAC- (left) and THC-positive drives (right) within the sample, depending on age group (18-24- vs. 25-39-year-olds) and study group (N_{User}=195 / $N_{Control}$=100)[51]. Within the control sample, the younger

[48] 30-days-prevalence of 40-64-year-old population: 0.7% / regular drug use (>3x in last 30 days): 0.3% (ESA 2006).
[49] Proportion of drives of 40+ population on all drives: 66.2% (MiD 2008).
[50] Prevalence of risky to high alcohol consumption of 40-49-year-olds: 11%, of 50-59-year-olds: 13.2%, of 60-64-year-olds:14.4% (ESA 2006).
[51] Confidence intervals can be seen in the Annex (Annex 17.6).

subjects drove less often with low BACs. The difference between the age groups diminishes as soon as higher BACs (≥0.03%) are considered. In the user sample, no difference is observable between the two age groups at low BACs. But the 18-24-year-olds exceed the percentage of BAC-positive drives of the 25-39-year-olds at higher alcohol levels. When it comes to THC, no clear age differences are observable.

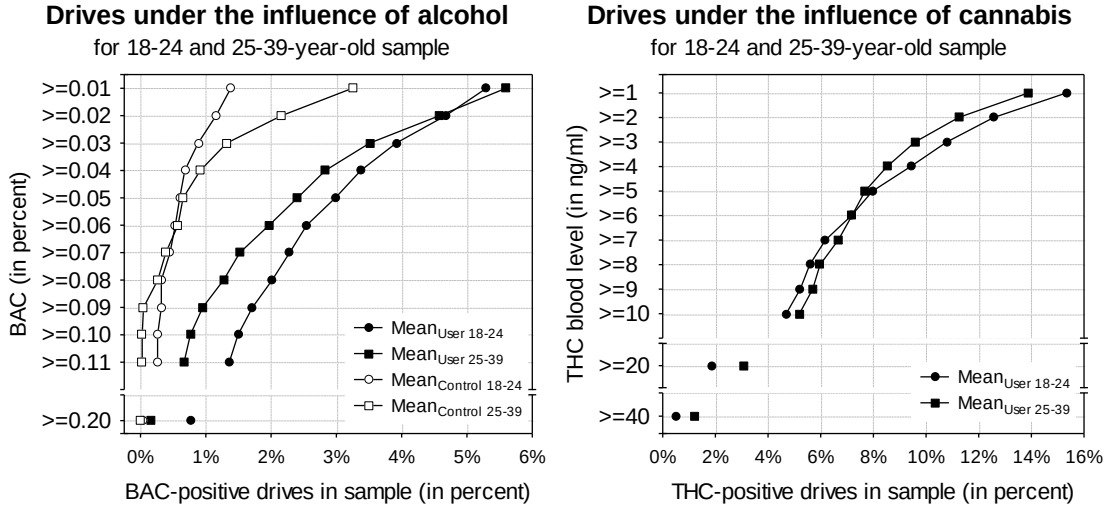


Figure 51: Mean percentage of BAC-/THC-positive drives of users (N_{User}=195) and mean percentage of BAC-positive drives of controls ($N_{Control}$=100) for 18-24-year-old and 25-39-year-old subjects.

Table 44: Mean percentage of BAC-/THC-positive drives of users (N_{User}=195) and mean percentage of BAC-positive drives of controls ($N_{Control}$=100) for 18-24-year-old and 25-39-year-old subjects.

BAC (in %)	18-24		25-39		THC blood plasma level (in ng/ml)	18-24	25-39
	Control	User	Control	User		User	
≥0.01	1.4%	5.3%	3.2%	5.6%	**≥1**	15.3%	13.9%
≥0.02	1.2%	4.7%	2.2%	4.6%	**≥2**	12.6%	11.2%
≥0.03	0.9%	3.9%	1.3%	3.5%	**≥3**	10.8%	9.6%
≥0.04	0.7%	3.4%	0.9%	2.8%	**≥4**	9.4%	8.5%
≥0.05	0.6%	3%	0.7%	2.4%	**≥5**	8%	7.7%
≥0.06	0.5%	2.5%	0.6%	2%	**≥6**	7.2%	7.2%
≥0.07	0.5%	2.3%	0.4%	1.5%	**≥7**	6.2%	6.7%
≥0.08	0.3%	2%	0.3%	1.3%	**≥8**	5.6%	6%
≥0.09	0.3%	1.7%	0%	1%	**≥9**	5.2%	5.7%
≥0.10	0.3%	1.5%	0%	0.8%	**≥10**	4.7%	5.2%
≥0.11	0.3%	1.4%	0%	0.7%	**≥20**	1.8%	3.1%
≥0.20	0%	0.8%	0%	0.1%	**≥40**	0.5%	1.2%

Through considering the prevalence rate for regular drug use within the two age groups[52], the prevalence within the 18-24- and 25-39-year-old population can be calculated as follows (here, the prevalence of BAC-positive drives in the 18-24-year-old population was calculated):

[52] Prevalence for regular drug use (>3x in last 30 days): 18-24 year-old population → 4.8% (±0.95 CI: 3.4% - 6.2%); 25-39 year-old population → 2.1% (±0.95 CI: 1.5% - 2.7%).

((100-4.8)*1.4 (controls' proportion) + 4.8*5.3 (users' proportion)) / 100

Figure 52 and Table 45 show the calculated prevalence rates and the confidence intervals (±0.95 CI) for the two age groups. Because the general drug use prevalence is more than twice as high for the 18-24-year-old population compared to the 25-39-year-olds, the prevalence rates for driving under the influence of cannabis are much higher in this age group, even if the differences in the occurrence of THC-positive drives within the sample were relatively small. Concerning BAC-positive drives, the calculated prevalences are mainly influenced by the occurrence of BAC-positive drives within the population that does not regularly use drugs (controls).

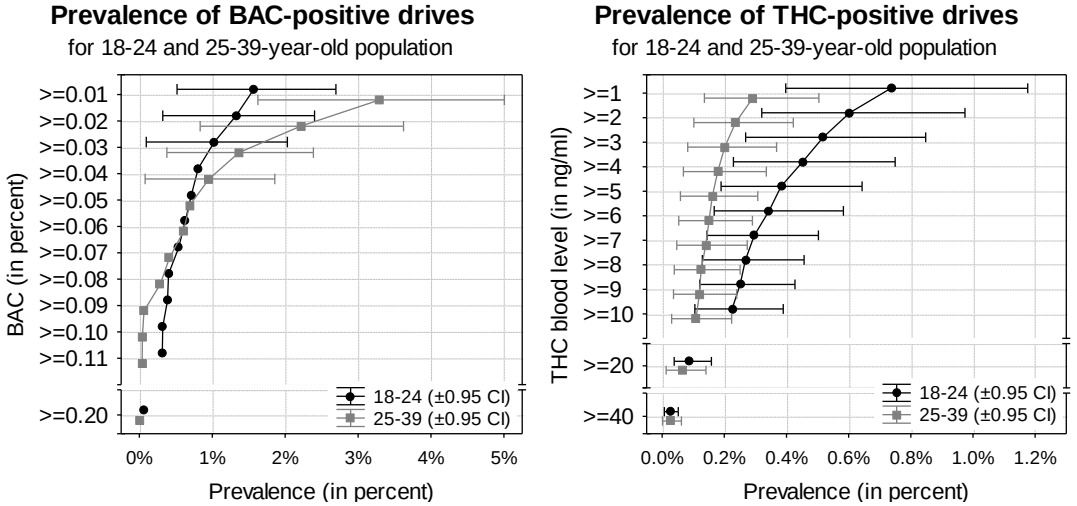


Figure 52: Prevalence of BAC- and THC-positive drives within the population of 18-24- and 25-29-year-olds, calculated from the survey results (in percent ±0.95 CI).

Table 45: Prevalence of BAC- and THC-positive drives within the population of 18-24- and 25-29-year-olds, calculated from the survey results (in percent ±0.95 CI).

BAC (in %)	Prevalence of BAC-pos. drives		THC blood level (in ng/ml)	Prevalence of THC-pos. drives	
	18-24	25-39		18-24	25-39
≥0.01	1.57 (0.52 - 2.7%)	3.3 (1.63 - 5%)	**≥1**	0.74% (0.4 - 1.18%)	0.29% (0.14 - 0.5%)
≥0.02	1.33 (0.32 - 2.4%)	2.21 (0.84 - 3.62%)	**≥2**	0.6% (0.32 – 0.97%)	0.24% (0.1 - 0.42%)
≥0.03	1.03 (0.09 - 2.03%)	1.37 (0.38 - 2.38%)	**≥3**	0.52% (0.27 - 0.85%)	0.2% (0.08 - 0.37%)
≥0.04	0.81 (-)	0.96 (0.08 - 1.86%)	**≥4**	0.45% (0.23 - 0.75%)	0.18% (0.07 - 0.34%)
≥0.05	0.71 (-)	0.69 (-)	**≥5**	0.38% (0.19 - 0.64%)	0.16% (0.06 - 0.31%)
≥0.06	0.63 (-)	0.6 (-)	**≥6**	0.34% (0.17 - 0.58%)	0.15% (0.05 - 0.29%)
≥0.07	0.54 (-)	0.41 (-)	**≥7**	0.3% (0.14 - 0.5%)	0.14% (0.05 - 0.27%)
≥0.08	0.4 (-)	0.28 (-)	**≥8**	0.27% (0.13 - 0.46%)	0.13% (0.04 - 0.25%)
≥0.09	0.39 (-)	0.06 (-)	**≥9**	0.25% (0.12 - 0.43%)	0.12% (0.04 - 0.24%)
≥0.10	0.32 (-)	0.04 (-)	**≥10**	0.23% (0.11 - 0.39%)	0.11% (0.03 - 0.22%)
≥0.11	0.31 (-)	0.04 (-)	**≥20**	0.09% (0.04 - 0.16%)	0.06% (0.01 - 0.14%)
≥0.20	0.06 (-)	0 (-)	**≥40**	0.03% (0.01 - 0.05%)	0.03% (0 - 0.06%)

14.8 Decisions against DUI

The present chapter will focus on trips that were travelled after the subjects decided against DUI by either abstaining from drug use because of a subsequent drive or from driving because of former or intended drug use. In Chapter 10.1.2, it was elaborately described how this substance use and driving interaction was queried.

In the case of a drive, the subjects had to declare if they had previously consumed any impairing substance (response option 1), regardless of the subsequent drive, or if they were indeed concerned about the drive and either restricted (response option 2) or abandoned consumption before driving (response option 3). If the consumption was not associated with the drive at all, i.e. the drive was no drive under influence and the subject did not abstain from substance use because of the drive, a fourth, neutral response option was chosen. In the case of a trip that was not travelled as driver of a motor vehicle, the subjects had to declare if they abstained from driving because of former substance use (response option 1) or because they intended to use impairing substances later on (response option 2). If the trip was not associated with drug use at all, this was indicated by a third, neutral response option.

Figure 53: Absolute number and percentages of all drug and drive combinations, separated for conflict situations and trips that imply no conflict for users (N_{User}=195) and controls ($N_{Control}$=100).

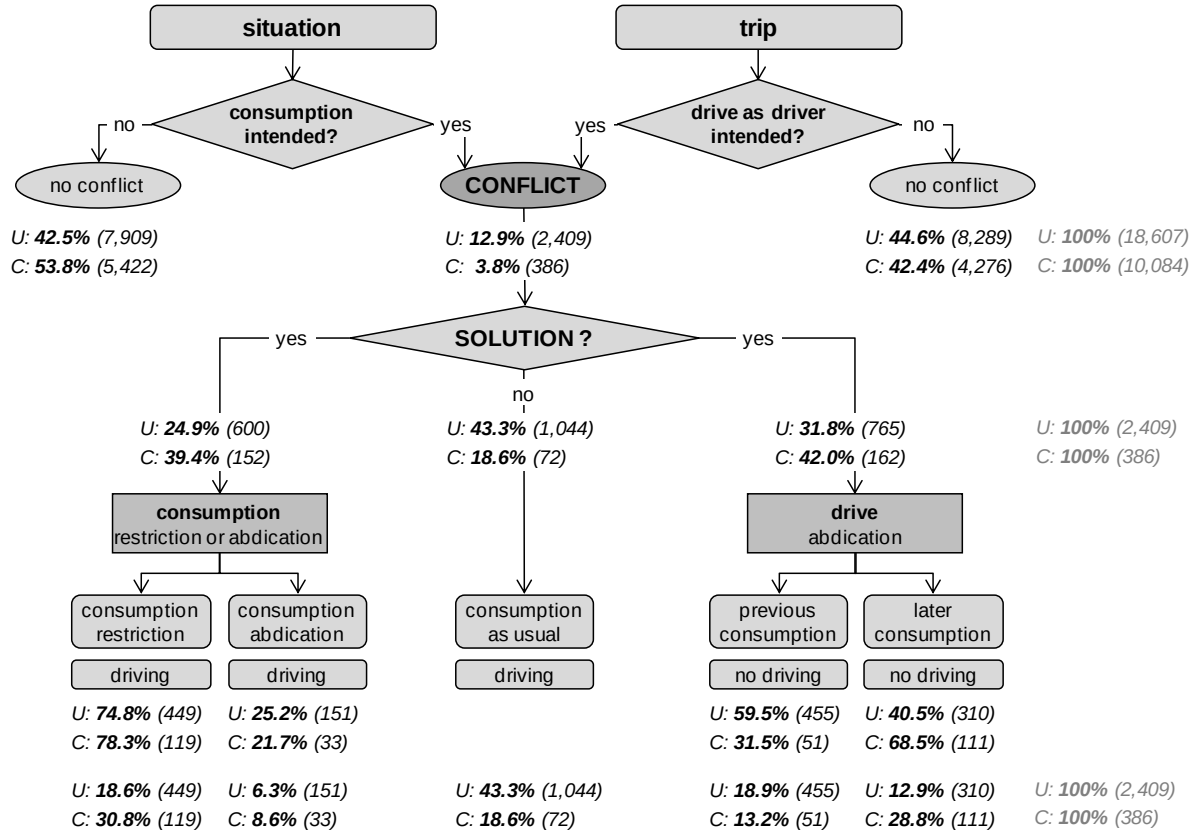


Figure 53 shows the absolute numbers and percentages of all conditions for users (N_{User}=195) and controls ($N_{Control}$=100). Trips that were not associated with DUI at all are indicated as trips that imply no conflict (*no conflict*). If trips were either drives

under influence or the subjects consciously decided against DUI by either refraining from substance use or by refraining from driving, the trips are indicated as *conflicts*.

Users had far more conflicts (12.9% of all users' trips) than controls (3.8% of all controls' trips). This is due to more drives that were consciously travelled under influence (users: 43.3% of all users' conflicts; controls: 18.6% of all controls' conflicts). Controls more often refrained from consumption (8.6% of all controls' conflicts) or consumed less than they usually had intended because of driving (30.8% of all controls' conflicts) compared to users (consumption abdication: 6.3% of all users' conflicts, consumption restriction: 18.6% of all users' conflicts). Additionally, controls more often refrained from driving because of consumption compared to users (controls: 42% of all controls' conflicts, users: 31.8% of all users' conflicts). Whereas users more often decided against driving after previous consumption (59.5% of all users' drive abdication conflicts), controls solved a conflict more often by deciding against driving before consumption had already taken place (68.5% of all controls' drive abdication conflicts).

The question arises whether this difference is caused by different decision strategies or simply by different consumption patterns. Cannabis was the main illegal drug that was used by the users. It was used all day long, whereas alcohol was mostly used in the evenings and at night (Chapter 14.5.1). Moreover, illegal drugs were mostly consumed at home (63.1%), whereas alcohol was consumed at home in only 25.3% (controls) to 29% (users) of the cases. 70.3% of the users' trips that were not travelled by a vehicle because of previous consumption were positive for illegal drugs and in 53.4% of these cases the place of departure was at home. When the subjects exclusively had a positive BAC, the place of departure was only in around 30% of the cases at home, no matter if users or controls are considered (users=31.1%; controls=33.3%). In the case the subjects decided not to drive in advance, the place of departure was in most of the cases at home (users=88.1%; controls=88.3%). This suggests that the difference between users and controls in decisions against driving because of consumption stems from the fact that users were already under influence when going out which was caused by a higher consumption rate per day and because they consume more often at home than in public places.

The users had 1,493 drives for which they indicated that they used drugs beforehand (1,044 without restriction and 449 after restricted substance use). According to the subjective statements for each drive, the controls had 191 drives under the influence of alcohol (72 without restriction and 119 after restricted alcohol use). This does not correspond to the number of DUI that was found by the more objective concentration-based classification calculated by the consumed dose and the time between consumption and driving (Chapter 13).

Figure 54 illustrates the difference between the number of objectively and subjectively classified drives under influence for users and controls. The subjective statement was set to 100% to point out an under- or overstatement of DUI compared to the number of DUI that was identified by the objective method applied in Chapter 14.7.2. When users stated that they consumed impairing substances before driving, in most of the cases (70%) they did not restrict the consumption (Figure 54 left, bar

#1). Controls restricted alcohol consumption in 60% of the cases (Figure 54 right, bar #1). Users had far more substance-positive drives than they stated they had (Figure 54 left, bar #2). The difference becomes smaller when only those drives are regarded as DUI that were positive for any illegal drug and/or were travelled with a BAC above the legal limit (Figure 54 left, bar #3). Controls reported more DUI than they actually had according to the objective classification (Figure 54 right, bar #2). The overreporting becomes even higher when only those drives were regarded that were travelled with a BAC above the legal limit (Figure 54 right, bar #3) and was still present then when the number of subjective statements is reduced to non-restricted alcohol use (Figure 54 right, bar #1).

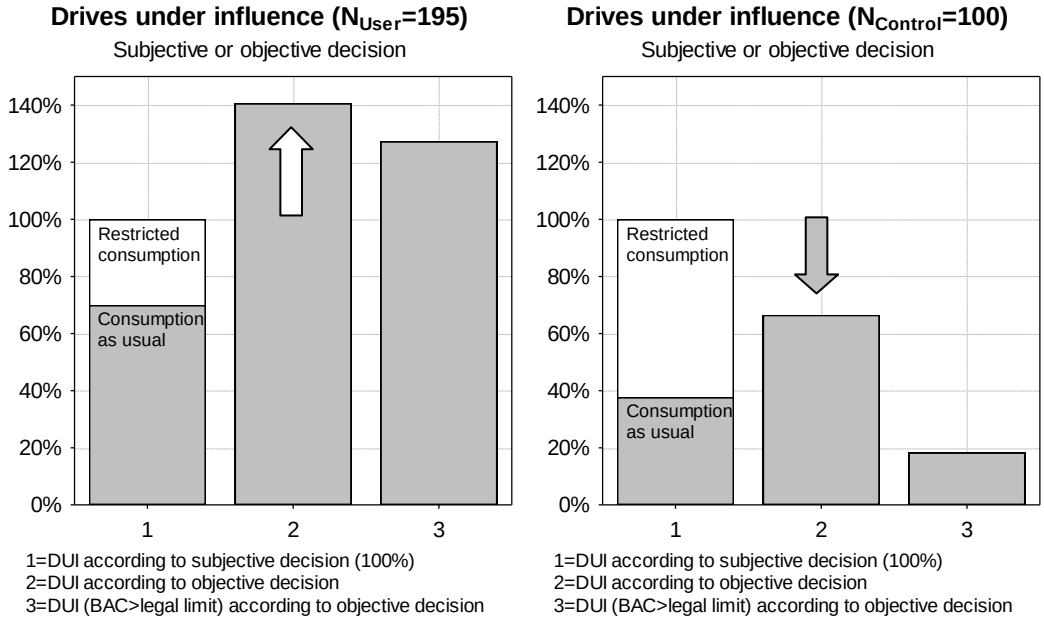


Figure 54: Occurrence of DUI according to subjective and objective decision for users (N_{User}=195) and controls ($N_{Control}$=100).

The users' underreporting of DUI could either be due to being unaware of being under influence or due to playing the incidences down. Especially when travelling with a low BAC or THC blood plasma level or when travelling after longer time periods between consumption and driving, an underreporting might be very likely. Controls reported more DUI than found in the objective data and stated more often that they reduced alcohol consumption because of a forthcoming drive compared to users. This indicates more caution and reduced alcohol consumption to the extent that they were again sober by the time of the drive.

14.9 Acute intoxication and subjective impairment

In this chapter, the BAC, THC blood plasma level and the time between last stimulants consumption and driving is shown for the different response options of the question concerning the reason for not driving (*previous consumption*, *later consumption*, *other reason*) and for each response option of the question about the

intention to drive under influence when a drive was reported (*no consumption*, *consumption as usual*, *consumption abdication*, *restricted consumption*). No concentration calculation was possible for stimulants. In the case of stimulants, no mathematical model about the relationship between consumed dose, consumption time, elimination and blood concentration exists. Therefore, the time between the last consumption of stimulants and driving was used to analyse how the level of intoxication influences decisions about driving. The different substances were analysed separately. Consider that for each analysis only those trips were included that were either sober or positive for the substance in question (independent of a positive value for any other substance).

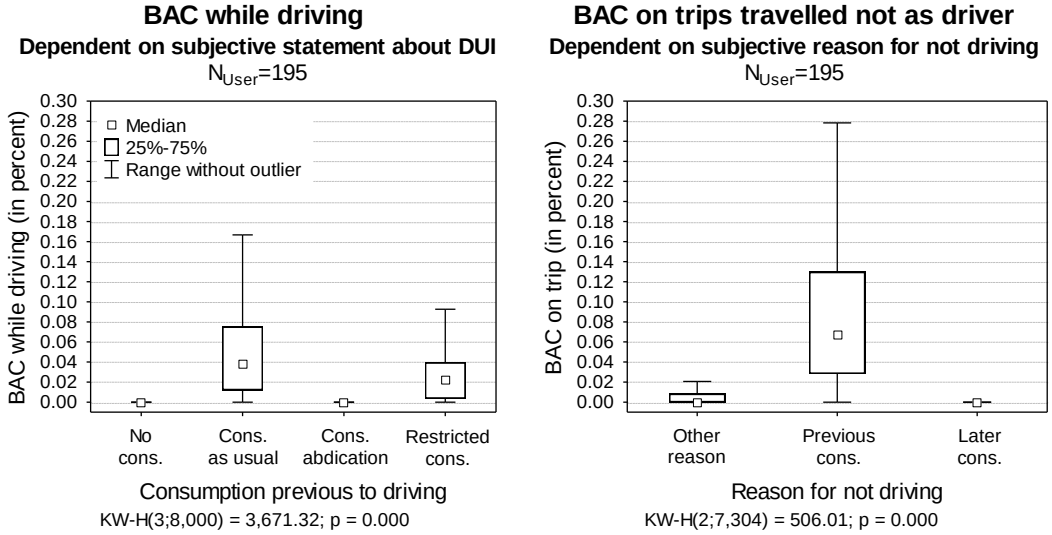


Figure 55: BAC on trip, depending on the subjective statement of users (N_{User}=195) about consumption previous to driving (no consumption, consumption as usual, consumption abdication, restricted consumption) and reason for not driving (other reason, previous consumption, later consumption) (Median, 25%-75%, Range without outlier).

When the users stated that they had used impairing substances before driving (*cons. as usual*), 50% of the corresponding BACs were above 0.04% and 50% beneath (Figure 55, left). When they restricted previous consumption (*restricted cons.*), the median BAC was 0.02%. The highest BACs were found for trips that were not travelled as driver of a vehicle because of previous consumption (*previous cons.*). The median BAC was 0.07% in this case (Figure 55, right). When the users stated that they did not use any drugs before driving (*no cons.*, *cons. abdication*), the majority of the corresponding BACs was zero. But for 215 drives out of 7,548 (2.8%), a BAC higher than 0.01% was found. 188 of these 215 (87.4%) drives were positive because of alcohol consumption on the previous day. Because the consumption was dated to further in the past, the users might have thought they were sober but actually were not.

When the controls stated that they drank alcohol before driving (*cons. as usual*), 50% of the corresponding BACs were above 0.02% and 50% beneath (Figure 56, left). When they restricted previous consumption (*restricted cons.*), the median BAC was 0.01%. The highest median BAC was found for trips that were not travelled as driver

of a vehicle because of previous consumption (*previous cons.*). The median BAC was 0.05% in this case (Figure 56, right). When the controls stated that they did not drink alcohol before driving (*no cons.*, *cons. abdication*), the greatest part of the corresponding BACs was negative. For 33 drives out of 5,455 (0.6%), a BAC higher than 0.01% was found. 29 of these 33 (87.9%) drives were positive because of alcohol consumption on the previous day.

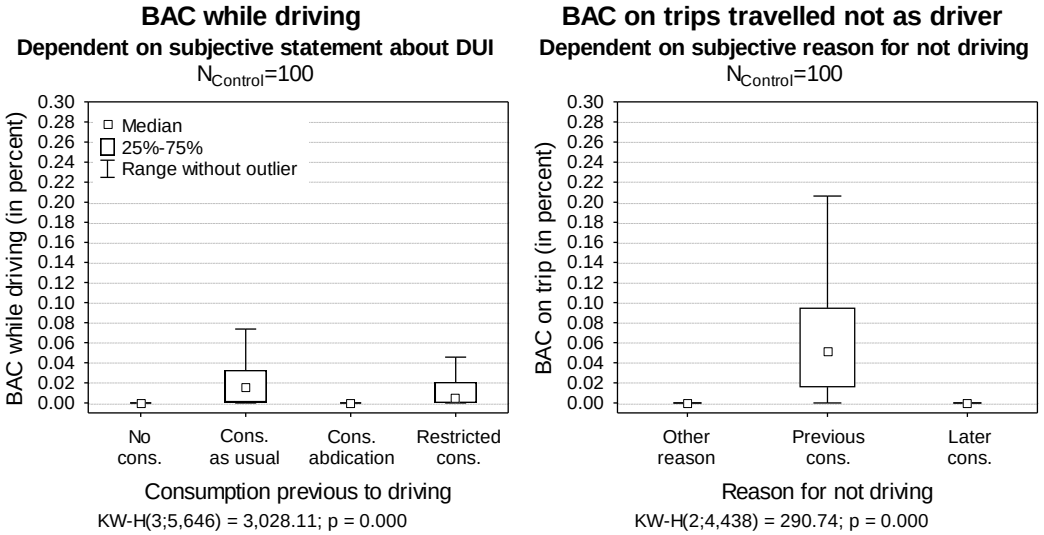
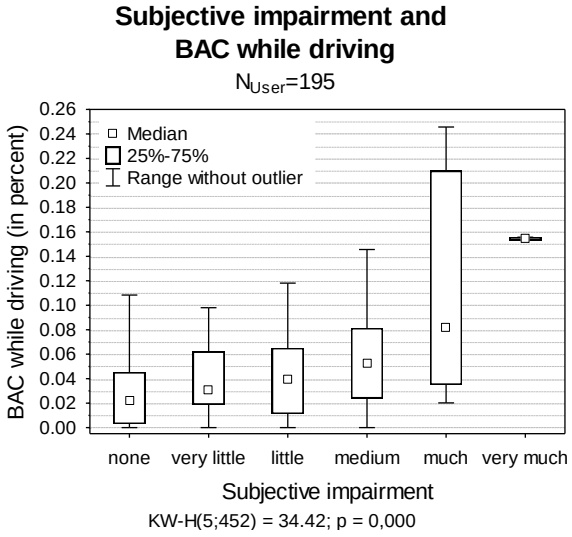


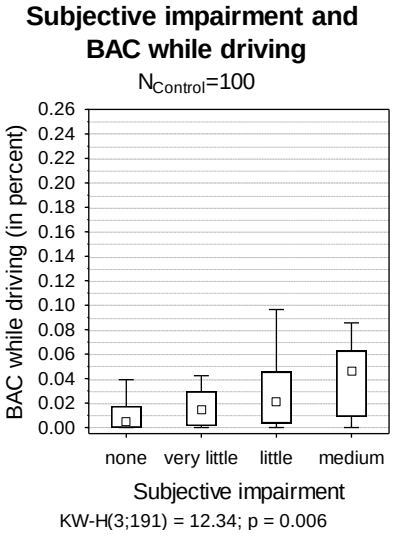
Figure 56: BAC on trip, depending on the subjective statement of controls ($N_{Control}$=100) about consumption previous to driving (no consumption, consumption as usual, consumption abdication, restricted consumption) and reason for not driving (other reason, previous consumption, later consumption) (Median, 25%-75%, Range without outlier).

When the subjects, regardless whether users or controls are considered, consciously drove after alcohol consumption (*cons. as usual*), the median BAC was below the main legal BAC limit of 0.05% (users: 0.04%; controls: 0.02%). When they restricted consumption because of driving (*restricted cons.*), the median BAC was even lower than 0.03%, which is the threshold for fitness to drive in Germany (users: 0.02%; controls: 0.01%). When the subjects refrained from driving because of consumption (*previous cons.*), the median BAC was as high as or higher than the main legal BAC limit in Germany (users: 0.07%; controls: 0.05%). When subjects were travelling under the influence of alcohol and were not aware of it (*no cons.*, *cons. abdication*), the positive BAC mainly stemmed from alcohol consumption on the previous day.

For each drive for which the subjects indicated that they had used drugs beforehand (either restricted or not), they were also asked how impaired they felt while driving (*none*, *very little*, *little*, *medium*, *much*, *very much*). Figure 57 shows the median BAC of users (left) and controls (right) on drives that were stated as drives after restricted or not restricted substance use for the different impairment categories. When users felt no impairment, they had a median BAC of 0.02%, controls had a median BAC of 0.01%. When users felt very little impaired, they had a median BAC of 0.03%, controls had a median BAC of 0.02% . When both users and controls felt medium impairment, 50% of the corresponding BACs were above 0.05% and 50% beneath. Controls never felt much or very much impaired while driving after alcohol

consumption. When users stated that they felt much impaired, the median BAC was 0.08%. When the impairment was given the rating very much, the median BAC was 0.15%. So, the higher the BAC was while driving, the more the subjects felt impaired.





Percent (number) of drives in each condition (users)

none	very little	little	medium	much	very much
56.9% (257)	18.1% (82)	15% (68)	6.9% (31)	2.7% (12)	0.4% (2)

Percent (number) of drives in each condition (controls)

none	very little	little	medium
65.4% (125)	19.9% (38)	12% (23)	2.6% (5)

Figure 57: BAC on drive, depending on the subjective impairment of users (N_{User}=195; left) and controls ($N_{Control}$=100; right) (Median, 25%-75%, Range without outlier).

When considering the different alcohol consumption groups (classification like in Chapter 14.5.3.1) separately (controls not included), it became obvious that lower consumption in general (moderate versus heavy verus excessive) leads to higher subjective impairment levels. While moderate users felt at least a medium impairment in 17.3% (18 out of 104) of BAC-positive drives, this percentage is lower for heavy users (9.3%; 20 out of 216) and the lowest for excessive users (5.3%; 7 out of 132). A medium positive correlation between objective intoxication and subjective impairment was found for moderate (r=0.41) and heavy users (r=0.36). For excessive users, the correlation was zero (r=0.00). For moderate alcohol users, a medium impairment correlates with a median BAC of 0.03%, for heavy users the corresponding value is 0.05% and for excessive users 0.08%.

When users stated that they used impairing substances before driving (*cons. as usual*), 50% of the corresponding THC blood plasma levels were above 8ng/ml and 50% beneath (Figure 58, left). When they restricted previous consumption (*restricted cons.*), the median THC blood plasma level was 4ng/ml. For trips that were not travelled as driver of a vehicle because of previous consumption (*previous cons.*), a median THC blood plasma level of 6ng/ml was found (Figure 58, right). Unlike in the case of conscious alcohol-positive drives, many rather high substance blood levels were found in the case of conscious THC-positive drives (*cons. as usual*). Most of these consciously intoxicated drives (61.2%) were travelled by excessive cannabis users, 23.6% by heavy users and 15.2% by moderate users. In general, the

excessive users had far more THC blood plasma levels of 8ng/ml and higher while driving compared to the other two consumption groups (excessive user: 72%, heavy users: 36.3%, moderate users: 23.8%). When users stated that they did not use any drugs before driving (*no cons.*, *cons. abdication*), the majority of the corresponding THC blood plasma levels was zero. Nevertheless, for 456 drives out of 7,789 (5,9%), a THC blood plasma level higher than 1ng/ml was found. 147 of these drives (32.2%) were caused by cannabis consumption on the previous day. 18 (3.9%) took place within one hour after consumption, 123 (27%) within one to three hours after consumption and the remaining 168 (36.8%) drives took place more than three hours after consumption.

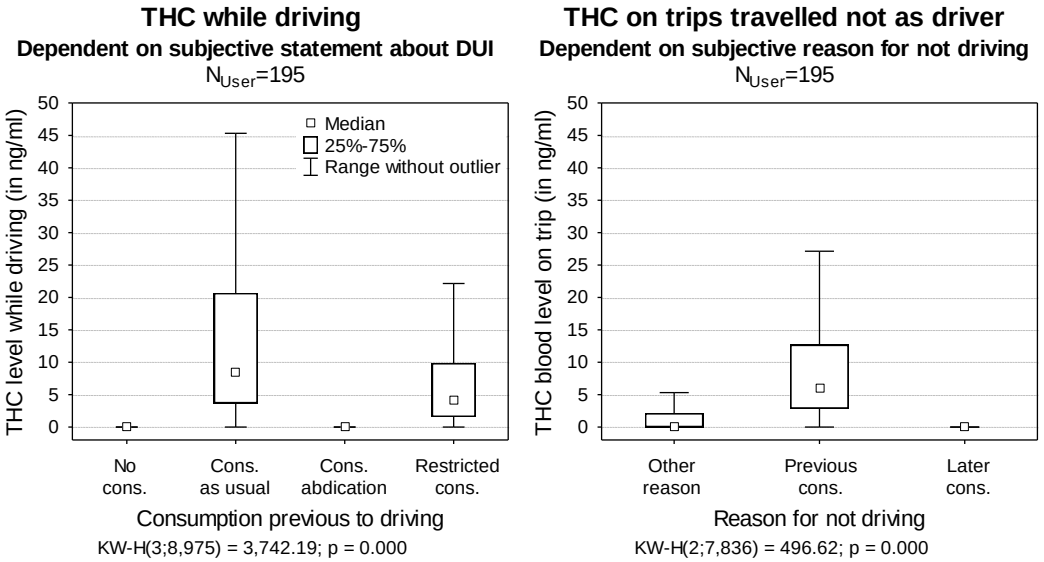
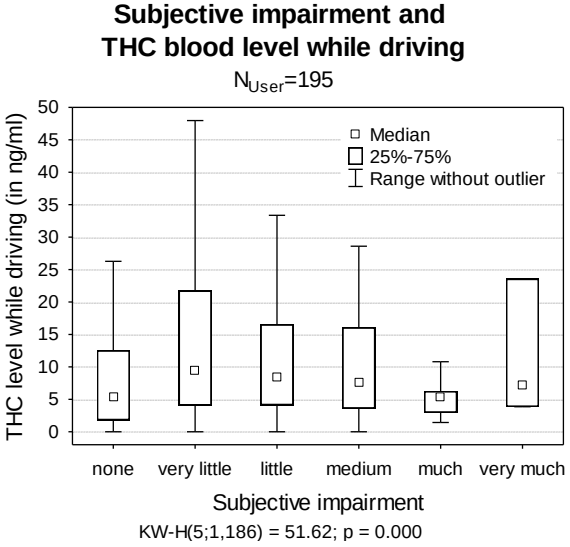


Figure 58: THC blood plasma level on trip, depending on subjective statement of users (N_{User}=195) about consumption previous to driving (no cons., cons. as usual, restricted cons., cons. abdication) and reason for not driving (other reason, previous cons., later cons.) (Median, 25%-75%, Range without outlier).



Number of drives within each condition (users)

none	very little	little	medium	much	very much
43.4% (515)	29.1% (345)	18.6% (221)	7.4% (88)	1.2% (14)	0.3% (3)
Moderate users					
46.3% (130)	18.5% (52)	19.6% (55)	11.4% (32)	3.9% (11)	0.4% (1)
Heavy users					
40.9% (119)	35.1% (102)	14.1% (41)	8.9% (26)	0.3% (1)	0.7% (2)
Excessive users					
43.3% (266)	31.3% (191)	20.4% (125)	4.9% (30)	0.3% (2)	0% (0)

Figure 59: THC blood plasma level on drive, depending on the subjective impairment of users (N_{User}=195; Median, 25%-75%, Range without outlier).

Figure 59 shows the THC blood plasma level on drives that were stated as drives after restricted consumption or consumption that was not restricted for the different impairment categories (N_{User}=195). In contrast to alcohol, no distinct dose-dependent impairment level was found. Regardless if the users felt no impairment or felt very much impaired, the corresponding median THC blood plasma levels ranged between four and 10ng/ml.

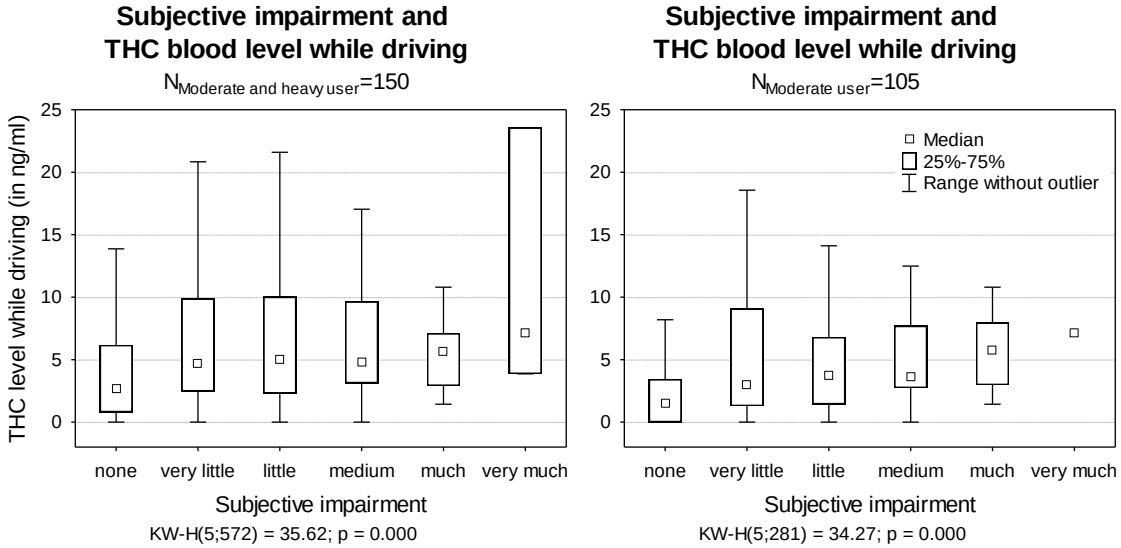


Figure 60: THC blood plasma level on drive, depending on the subjective impairment of moderate and heavy users ($N_{Moderate\ and\ heavy\ user}$=150) and of moderate users alone ($N_{Moderate\ user}$=105) (Median, 25%-75%, Range without outlier).

When considering the different consumption groups separately, it became obvious that lower consumption in general leads to higher subjective impairment levels. While the moderate users felt at least a medium impairment in 15.7% (44 out of 281) of their THC-positive drives, this percentage is lower for heavy users (10%; 29 out of 291) and the lowest for excessive users (5.2%; 32 out of 614). When the excessive users are excluded (Figure 60, left) or only moderate cannabis users are taken into account (Figure 60, right), a dependence of THC blood plasma level and impairment comparable to alcohol can be found. The correlation between objective intoxication and subjective impairment was lower than in the case of alcohol. A small correlation between objective intoxication and subjective impairment was found for moderate (r=0.18) and heavy users (r=0.15). For excessive users, again, no significant correlation was found (r=0.09). For moderate cannabis users, a medium impairment correlates with a median THC blood plasma level of 3.7ng/ml, for heavy users the corresponding value is 7.5ng/ml and for excessive users 18ng/ml.

When the stimulants users stated that they used impairing substances before driving (*cons. as usual*), the median time between stimulants consumption and driving was two hours (Figure 61, left). When they restricted previous consumption (*restricted cons.*), the median time delay was six hours. In the case of abdication from driving because of previous consumption (*previous cons.*), the last stimulants consumption was only three hours prior to the trip (Figure 61, right).

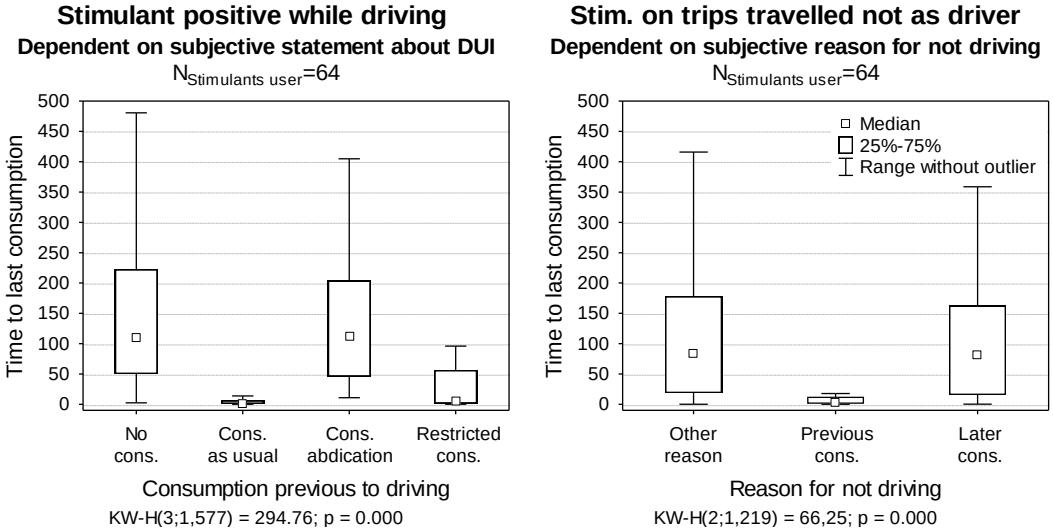


Figure 61: Time between last stimulants consumption and trip, depending on the subjective statement of stimulants users ($N_{StimulantsUser}$=64) about consumption previous to driving (no cons., cons. as usual, cons. abdication, restricted cons.) and reason for not driving (other reason, previous cons, later cons.) (Median, 25%-75%, Range without outlier).

When the users stated that they did not use any drugs before driving (*no cons.*, *cons. abdication*), in most of the cases the drives were classified as stimulant-negative and, if any, the last consumption of stimulants was 100 hours or more ago. Anyhow, 84 drives out of 7,417 (1.1%) were classified as positive for stimulants. For 45 of the 84 (53.6%) drives, the stimulants consumption took place 12 hours or more in the past.

For alcohol, a dose-dependent decision making according to the current legal restrictions in Germany and, for moderate and heavy alcohol users, a dose-dependent subjective impairment (median BAC for medium impairment: 0.03%-0.05%) was found. The subjective impairment of excessive alcohol users did not correlate with the objective intoxication. A dose-dependent impairment was also found for moderate to heavy cannabis users (median THC blood plasma level for medium impairment: 4-8ng/ml), whereas excessive users felt highly impaired rather seldom but committed drug driving with rather high THC blood plasma levels. It was also found that the subjects are usually not aware of driving under influence when the consumption took place further back in time, especially when the consumption took place on the previous day.

14.10 Impairing effects of drug use on psychometric performance

The computer-based Act & React Test System (ART) 2020 Standard test battery that was developed by the Austrian Road Safety Board (ARSB) was applied to assess cognitive measures that are closely associated with driving abilities. In total, 147 subjects went through the test battery (Chapter 10.5). It was planned to analyse the effect of lifetime drug use (Control, LightUse, HeavyUse; groups described in Chapter 14.10.2) and acute cannabis intoxication (NoAcuteCann, AcuteCann; groups described in Chapter 14.10.1) on psychometric performance. The final sample

consisted of 132 subjects (N_{User}=90; $N_{Control}$=42). All users that were included into the analyses reported a lifetime cannabis use of more than 40 times. 15 subjects were excluded from analysis because of the following reasons:

- Six controls did not completely go through all tests (two of them also reported a lifetime drug use of more than 40 times)
- Seven controls reported a lifetime drug use of more than 40 times
- One user reported a lifetime cannabis use of less than 40 times
- One user did not deliver a urine sample

The following parameters were analysed:

- Percentage of subjects who failed the complete ART2020 test-battery and percentage of subjects who failed the single sub-tests (MAT, Q1, LL5, GEMAT3, PVT, SENSO, RST3): Raw scores were transformed into percentage values according to the reference sample. According to the Guidelines for Expertise on Driver Aptitude Chapter 2.5 ("Begutachtungs-Leitlinien zur Kraftfahrereignung"; Lewrenz, 2000), a sub-test is failed if the subject reached a percentage value below 16. The whole battery is failed if at least one sub-test was failed.
- Number of succeeded tests.
- Mean raw scores for each parameter of the different sub-tests (MAT, Q1, LL5, GEMAT3, PVT, SENSO and RST3). Multivariate Analyses of Variance were applied for each test. If the global result was significant or marginally significant, t-tests were applied afterwards. Because of this hierarchical testing procedure, alpha-adjustment was not necessary. The SENSO consists of 17 parameters, the RST3 of 12 parameters, and both tests are run in three phases. The Multivariate Analyses of Variance were calculated for each phase separately.
- Number of succeeded parameters.

14.10.1 Acute effects of cannabis

Either before or after the performance testing with the ART2020, a urine sample was collected. Of the controls who completed the ART2020 and were not excluded because of their lifetime drug use, no one had a urine sample positive for the analysed substances ($N_{Control}$=42). Of the users who were included in the analyses (N_{User}=90), no one had a urine sample positive for opiates. Users with a urine sample positive for amphetamines or cocaine were excluded from the analysis (N=6). Because all users were regular cannabis users and a urine sample mainly measures the metabolites of cannabis, it is not surprising that of the remaining 84 users, 77.4% (N=65) were positive for cannabinoids. Only users with a positive urine sample on cannabis and a calculated BAC of zero when being tested by the ART2020 were included (N=64). They were categorised according to whether or not the calculated THC blood plasma level at the time of being tested by the ART2020 was zero and above zero, respectively ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16[53]).

[53] Calculated THC blood plasma level (in ng/ml): MEAN=5.51, MIN=0.14, $Q_{.25}$=1.06, MD=3.49, $Q_{.75}$=10.05, MAX=21.6.

Users who were not acutely intoxicated by cannabis (*NoAcuteCann*) and those who were acutely intoxicated (*AcuteCann*) did not differ in their current consumption rate concerning alcohol and stimulants (Figure 62, Table 46). Their experience with drugs in general (lifetime drug use light or heavy, categories described in Chapter 14.10.2) did not differ either. But, acutely cannabis intoxicated users were more often excessive cannabis users than not acutely intoxicated cannabis users.

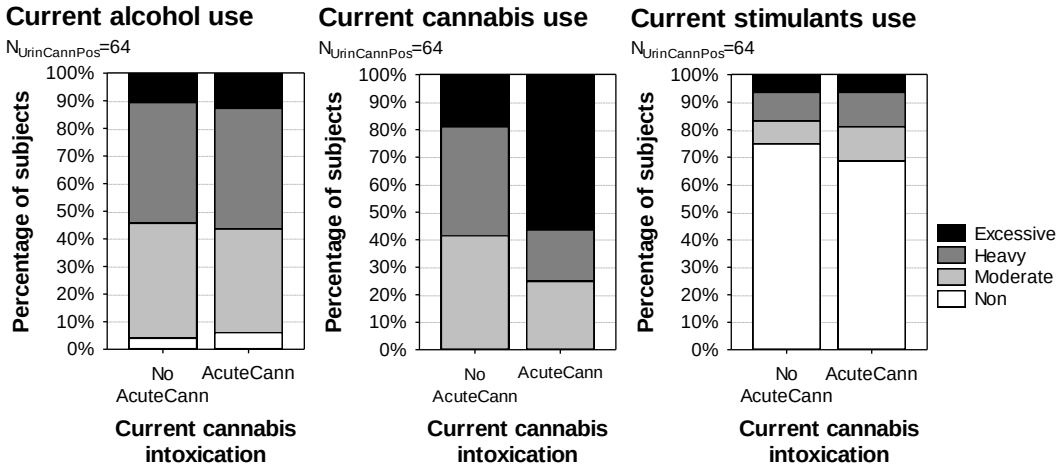


Figure 62: Percentage of non, moderate, heavy or excessive alcohol (left), cannabis (middle) and stimulants use (right) for acutely not intoxicated and acutely cannabis intoxicated users ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16).

Table 46: Percentage of heavy and excessive substance use and statistics for acutely not intoxicated and acutely cannabis intoxicated users ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16).

	Percentage of heavy and excessive users (analysis over all user categories)			
Current use	**Percent$_{NoAcuteCann}$ (±0.95 CI)**	**Percent$_{AcuteCann}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
Alcohol	54.2% (40.1%-68.3%)	56.3% (31.9%-80.6%)	0.2 (3)	0.977
Cannabis	58.3% (44.4%-72.3%)	75% (53.8%-96.2%)	7.87(2)	0.020
Stimulants	16.7% (6.1%-27.2%)	18.8% (-)	0.32 (3)	0.956

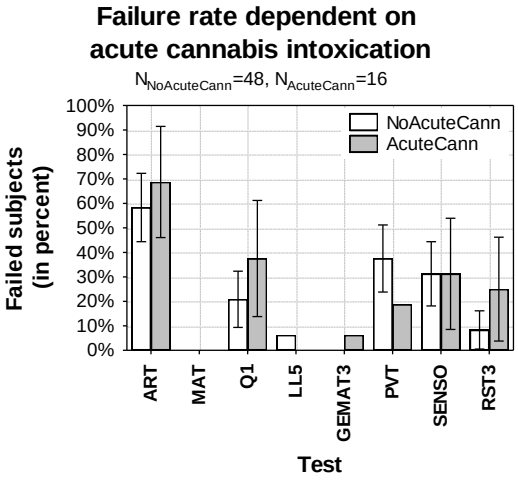


Figure 63: Failure rate in the whole test battery (ART) and the single sub-tests (MAT, Q1, LL5, GEMAT3, PVT, SENSO, RST3), depending on acute cannabis intoxication ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16; in percent, ±0.95CI).

Those users who were acutely intoxicated by cannabis while performing the ART2020 did not perform significantly worse than those users who were not acutely under influence (based on failure rates; Figure 63, Table 47). Concerning the Q1, the GEMAT3, the PVT and the RST3 trends were found. Users who were acutely intoxicated tended to perform worse in the Q1, the GEMAT3 and the RST3, whereas not intoxicated users tended to perform worse in the PVT. With regards to the GEMAT3, it has to be kept in mind that only one person failed in total. The total number of succeeded tests did not differ between the analysed subject groups.

Table 47: ART2020 failure rate and statistics per test for users with and without acute cannabis intoxication ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16).

Failure rate				
Test	**Percent$_{NoAcuteCann}$ (±0.95 CI)**	**Percent$_{AcuteCann}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
ART	58.3% (44.4%-72.3%)	68.8% (46%-91.5%)	0.56 (1)	0.455
MAT	0%	0%		
Q1	20.8% (9.3%-32.3%)	37.5% (13.8%-61.2%)	1.68 (1)	0.195
LL5	6.3% (-)	0% (-)	1.77 (1)	0.183
GEMAT3	0%	6.3% (-)	2.82 (1)	0.093
PVT	37.5% (23.8%-51.2%)	18.8% (0%-37.9%)	2.05 (1)	0.152
SENSO	31.3% (18.1%-44.4%)	31.3% (8.5%-54%)	0 (1)	1
RST3	8.3% (0.5%-16.2%)	25% (3.8%-46.2%)	2.7 (1)	0.101

When applying the evaluation procedure that was recommended by the Guidelines for Expertise on Driver Aptitude, the sensitivity and specificity of the ART2020 test battery was calculated as follows:

		Acute cannabis intoxication		
		AcuteCann	NoAcuteCann	
Test battery	failed	11 (a)	28 (b)	a+b
	passed	5 (c)	20 (d)	c+d
		a+b	b+d	

Sensitivity: $\frac{a}{a+b}$ = 68.8%

Specificity: $\frac{d}{b+d}$ = 41.7%

The **sensitivity** of a test measures the proportion of actual positives that are correctly identified as such (in the present example the percentage of acutely intoxicated subjects who failed the test battery). The **specificity** of a test measures the proportion of negatives that are correctly identified (in the present example the percentage of sober subjects who passed the test battery). Both characteristic values are rather low (for the whole test battery as well as for the sub-tests, the latter values are not listed here). So, the above reported results have to be interpreted with care.

The number of succeeded parameters (succeeded if a percentage value of 16 or higher was reached) did not differ between the analysed study groups. With respect to the raw scores of the single parameters, only some differences could be isolated

(Table 48, significant results and trends)[54]. In the Q1, those who were acutely intoxicated tended to have a higher number of processed items but also had a higher percentage of errors. The number of correct responses in the GEMAT3 differed significantly between the analysed subject groups. Acutely cannabis intoxicated users had less correct responses than those who were not acutely intoxicated. In phase 3 of the RST3, the intoxicated users made more mistakes accompanied by a tendency to have less correct responses. In phase 1, they tended to have less delayed reactions but also more errors.

Table 48: Mean scores and statistics of significant ART2020 parameters for users with and without acute cannabis intoxication ($N_{NoAcuteCann}$=48, $N_{AcuteCann}$=16).

Parameter scores				
Test	**$Mean_{AcuteCann}$ (±0.95 CI)**	**$Mean_{NoAcuteCann}$ (±0.95 CI)**	**t**	**p-value**
Q1				
ProcessedItems	741.6 (678.3-804.9)	696.4 (665-727.8)	1.41	0.163
%Errors	2.4 (1.7-3)	1.7 (1.3-2.1)	1.82	0.074
GEMAT3				
CorrectResponses	20.8 (19.3-22.2)	22 (21.4-22.5)	-2.03	0.047
RST3				
%DelayedReactions1	0.8 (0.2-1.4)	1.4 (1-1.9)	-1.44	0.156
%Errors1	2.1 (1.1-3.1)	1.3 (1-1.7)	1.81	0.075
CorrectResponses3	102.7 (100.8-104.5)	104.3 (103.2-105.4)	-1.55	0.126
%Errors3	4.8 (3.2-6.4)	3 (2.4-3.7)	2.64	0.011

14.10.2 Long-term effects of drug use

To analyse the long-term effects of drug use on the performance in the ART2020, only users with a negative urine screening result for amphetamines, cocaine and opiates, and users who were not acutely intoxicated by alcohol or cannabis (calculated BAC=0, negative urine result for cannabis or positive urine result for cannabis and a calculated THC blood plasma level of 0ng/ml) were included in the analyses. Furthermore, users with a negative drug screening result and a lower creatinine value than 20 dl/ml were excluded from analyses because a lowered creatinine level could implicate that the sample is diluted and a false negative outcome is likely to occur. So, the final sample size consisted of 42 controls and 64 users.

The users were further categorised into users with a light lifetime drug use ($N_{LightUse}$=46) and users with a heavy lifetime drug use ($N_{HeavyUse}$=18) according to the user classes that were defined in Chapter 12.2.1 (Table 49, LightUse: CanOnly and CanOthLow, HeavyUse: CanOthHigh and CanHer).

Users who were examined here (*LightUse*, *HeavyUse*) show higher current alcohol consumption than controls (Figure 64, left; Table 50). Whether users have a light or heavy lifetime drug use history does not affect their current cannabis consumption (Figure 64, middle). But, users with heavy lifetime drug consumption were currently

[54] A list of all parameters of each test together with the corresponding failure rates according to the Guidelines for Expertise on Driver Aptitude Chapter 2.5 ("Begutachtungs-Leitlinien zur Kraftfahrereignung"; Lewrenz, 2000) can be found in the Annex (Annex 17.7).

more often excessive and heavy stimulants users than those with a light lifetime drug use (Figure 64, right).

Table 49: User classes based on frequency of previous drug consumption and number of users in each class and category, respectively (N_{User}=64).

			Lifetime drug consumption			N_{User}=64
Category	**User class**	**Class description**	**Cann**	**Stim/Hallu/Oth**	**Her**	
LightUse	CanOnly	Cannabis only	**>40x**	0x	0x	17
	CanOthLow	Cannabis and sometimes stimulants and/or sometimes hallucinogens and/or sometimes other drugs and/or sometimes high potential drugs	**>40x**	<10x	<10x	29
HeavyUse	CanOthHigh	Cannabis and oftentimes stimulants and/or oftentimes hallucinogens and/or oftentimes other drugs and/or sometimes high potential drugs	**>40x**	**>10x**	<10x	16
	CanHer	Cannabis and oftentimes high potential drugs	**>40x**	not specified	**>10x**	2

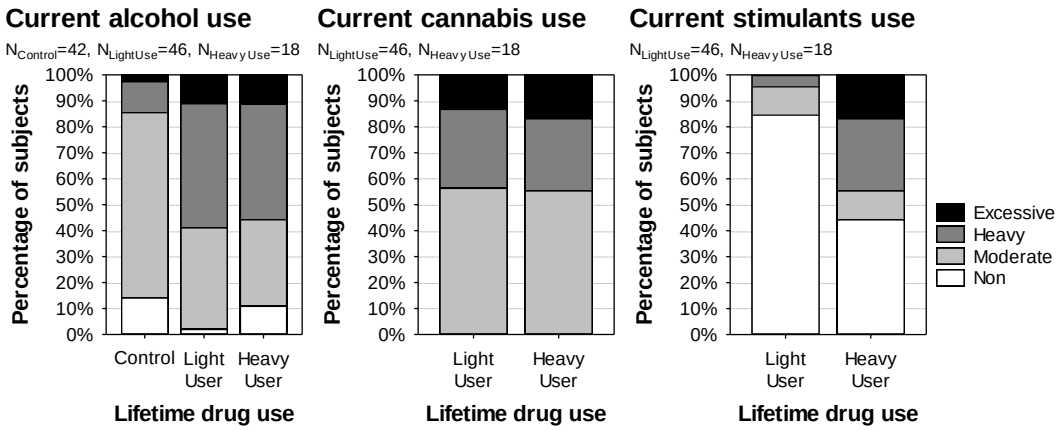


Figure 64: Percentage of non, moderate, heavy or excessive alcohol (left), cannabis (middle) and stimulants use (right) for controls and users with a light and heavy lifetime drug use ($N_{Control}$=42, $N_{LightUse}$=46, $N_{HeavyUse}$=18).

Table 50: Percentage of heavy and excessive substance use and statistics for controls and users with a light and heavy lifetime drug use ($N_{Control}$=42, $N_{LightUse}$=46, $N_{HeavyUse}$=18).

Percentage of heavy and excessive users (analysis over all user categories)					
Current use	**$Perc_{Control}$ (±0.95 CI)**	**$Perc_{LightU.}$ (±0.95 CI)**	**$Perc_{HeavyU.}$ (±0.95 CI)**	**chi-squ. (df)**	**p-value**
Alcohol	14.3% (4.5%-24.1%)	58.7% (44.3%-73.1%)	55.6% (34.9%-80.9%)	24.03 (6)	0.001
Cannabis		43.5% (30.2%-56.8%)	44.4% (21.4%-62.8%)	0.15 (2)	0.928
Stimulants		4.3% (-)	44.4% (21.4%-62.8%)	16.41 (3)	0.001

Those users who have a heavy or light lifetime drug use did not perform significantly worse on the ART2020 than controls (based on failure rates; Figure 65, Table 51). A very slight effect was found for the PVT that suggests that heavy drug users failed the test more often than light users and controls. The total number of succeeded tests did not differ between the analysed subject groups.

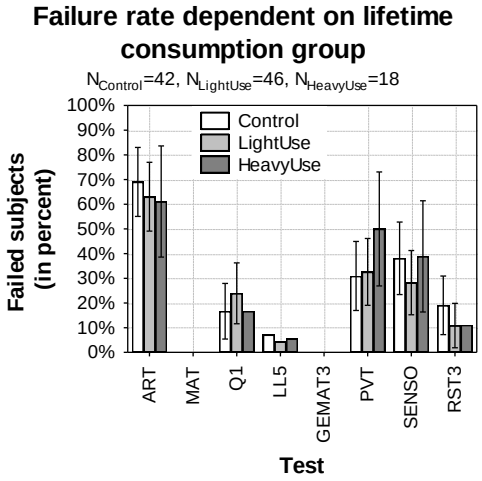


Figure 65: Failure rate in the whole test battery (ART) and the single sub-tests (MAT, Q1, LL5, GEMAT3, PVT, SENSO, RST3), depending on lifetime consumption group ($N_{Control}$=42, $N_{LightUse}$=46, $N_{HeavyUse}$=18; in percent, ±0.95CI).

Table 51: ART2020 failure rate and statistics per test for users (heavy or light use) and controls ($N_{Control}$=42, $N_{LightUse}$=46, $N_{HeavyUse}$=18).

Failure rate					
Test	**$Perc_{HeavyU.}$ (±0.95 CI)**	**$Perc_{LightU.}$ (±0.95 CI)**	**$Perc_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
ART	61.1% (38.6%-83.6%)	63% (49.1%-77%)	69% (55.1%-83%)	0.5 (2)	0.778
MAT	0%	0%	0%		
Q1	16.7% (-)	23.9% (11.6%-36.2%)	16.7% (5.4%-27.9%)	0.85 (2)	0.652
LL5	5.6% (-)	4.3% (-)	7.1% (-)	0.32 (2)	0.852
GEMAT3	0%	0%	0%		
PVT	50% (26.9%-73.1%)	32.6% (19.1%-46.2%)	31% (17%-44.9%)	2.12 (2)	0.346
SENSO	38.9% (16.4%-61.4%)	28.3% (15.2%-41.3%)	38.1% (23.4%-52.8%)	1.19 (2)	0.551
RST3	11.1% (-)	10.9% (1.9%-19.9%)	19% (7.2%-30.9%)	1.34 (2)	0.510

By the results of the present analyses, the **sensitivity** (in the present example the percentage of heavy lifetime drug users who failed the test battery) and the **specificity** (in the present example the percentage of controls who passed the test battery) were calculated as in Chapter 14.10.1:

$$\textbf{Sensitivity: } \frac{a}{a+b} \textbf{ = 61.1\%}$$

$$\textbf{Specificity: } \frac{d}{b+d} \textbf{ = 31\%}$$

The ART2020 and the recommended evaluation procedure, respectively, do not seem to be an adequate measure to identify neither acute effects of cannabis intoxication nor long-term effects of drug use – as operationalised in the present study. It has to be kept in mind that the sample of the present study mainly consisted of cannabis users. Only two subjects who were surveyed in the present context were using heroin on a regular basis in their life.

The number of succeeded parameters did not differ between the analysed study groups. When analysing the raw scores of the parameters, some differences between the subject groups could be isolated (Table 52, significant results and

trends)[55]. In the MAT, the controls had the most correct responses, followed by the light users. The lowest number of correct responses was found for the heavy users. In the LL5, heavy users had a lower number of processed items compared to light users and controls. The controls tended to have a higher percentage of errors compared to light users. Their percentage of errors was as high as that of the heavy users. Users with a heavy lifetime drug use had less correct responses in the GEMAT3 than those who have a light lifetime drug use and controls. In phase 1 of the RST3, the heavy users and the controls tended to make more mistakes compared to light users. In phase 2, the heavy users tended to have the fewest number of correct responses accompanied by the highest percentage of omissions.

Table 52: Mean scores and statistics of significant ART2020 parameters for users with heavy and light lifetime drug use and controls ($N_{Control}$=42, $N_{LightUse}$=46, $N_{HeavyUse}$=18).

Parameter scores					
Test	**$Mean_{HeavyU.}$ (±0.95 CI)**	**$Mean_{LightU.}$ (±0.95 CI)**	**$Mean_{Control}$ (±0.95 CI)**	**F**	**p-value**
MAT					
CorrectResponses	10.6 (9.7-11.4)	11.8 (11.3-12.4)	12.4 (11.9-13)	6.84	0.002
LL5					
ProcessedItems	30.2 (28.2-32.1)	34.4 (33.1-35.7)	34.1 (32.8-35.4)	7.01	0.001
%Errors	2.6 (1.1-4.1)	2 (1.2-2.9)	3.5 (2.3-4.6)	2.14	0.113
GEMAT3					
CorrectResponses	21.3 (20.3-22.2)	22.3 (21.7-22.8)	22.4 (21.9-22.8)	2.86	0.062
RST3					
%Errors1	1.9 (0.8-3)	1.3 (1-1.7)	1.9 (1.4-2.5)	1.69	0.190
CorrectResponses2	97.4 (91.5-103.2)	102 (100.5-103.5)	101.2 (99.3-103.1)	2.94	0.057
Omissions2	8.2 (3-13.5)	4 (2.9-5)	4.5 (3.1-5.9)	3.81	0.025

14.11 Situational characteristics of DUI

14.11.1 DUI as a function of time

In Chapter 14.6.1, the daily distribution of drives was shown compared between weekdays and weekends. For this purpose, the absolute number of drives per hour and weekday/weekend day was divided by the absolute number of weekdays and weekend days, respectively. So, the mean number of drives was shown for each hour. The mean numbers of drives for all 24 hours add up to the mean number of drives per day. In the following, this procedure is also applied to show the daily distribution of DUI.

On weekdays, users drove on average 0.35 of 1.86 drives (18.8%) under the influence of alcohol, cannabis or other substances or drug combinations (Figure 66). On weekends, this number rises to 0.43 of 1.33 drives (32.3%). On weekdays, there is a small increase around 6-9am when the subjects usually drive to school or job. In around 50% of these cases, the main substance effect stems from the night or day

[55] A list of all parameters of each test together with the corresponding failure rates according to the Guidelines for Expertise on Driver Aptitude Chapter 2.5 ("Begutachtungs-Leitlinien zur Kraftfahrereignung"; Lewrenz, 2000) can be found in the Annex (Annex 17.7).

before (Annex 17.5). Both on weekdays and weekends from 11pm onward, users drove in around 50% of the cases under influence.

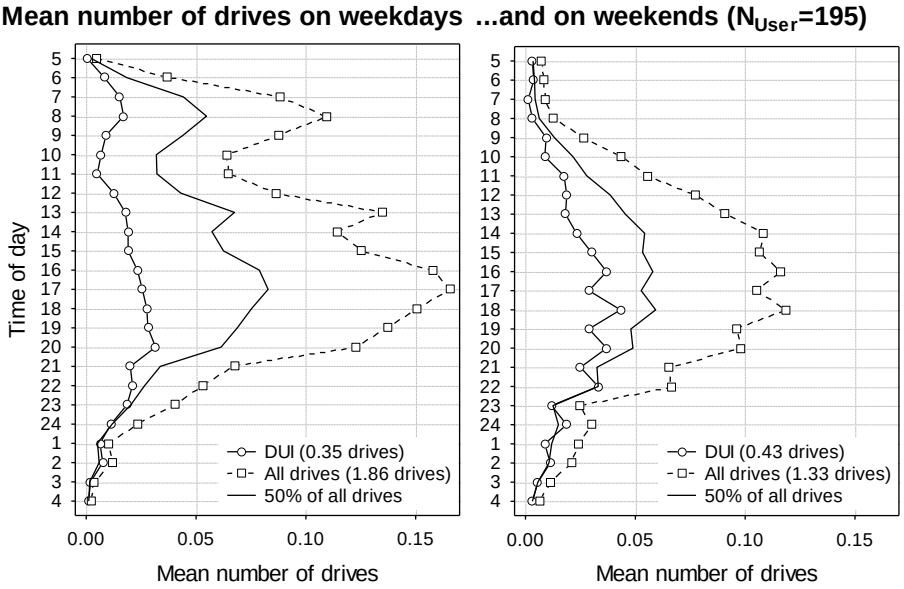


Figure 66: Number of DUI and total number of drives on weekdays/weekends for users (N_{User}=195).

As already mentioned in Chapter 14.7.2, users drove more than twice as often with a positive BAC than controls. Whereas the controls' positive drives (BAC≥0.01%) were basically restricted to common times for going out (8pm-2am), users had numerous BAC-positive drives from 2am until 6am and on weekends even until 12pm (Figure 67). In general, users stayed up longer and consumed more alcohol at night – as lined out in Chapter 14.4.1 and 14.5.1. The fact that users drank higher doses of alcohol than controls might result in more residual alcohol concentrations in the morning and could therefore explain the high percentage of BAC-positive drives on weekends in the category that covers the time from 6am until noon.

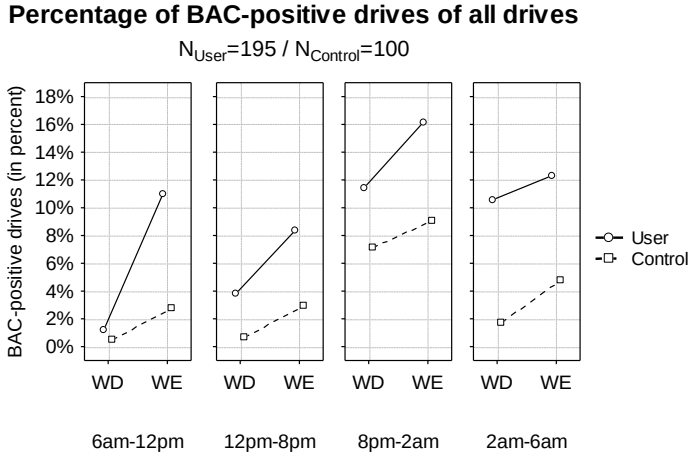


Figure 67: Percentage of BAC-positive drives (BAC≥0.01%) of all drives of users (N_{User}=195) and controls ($N_{Controls}$=100), depending on weekday (WD=weekday, WE=weekend) and time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am).

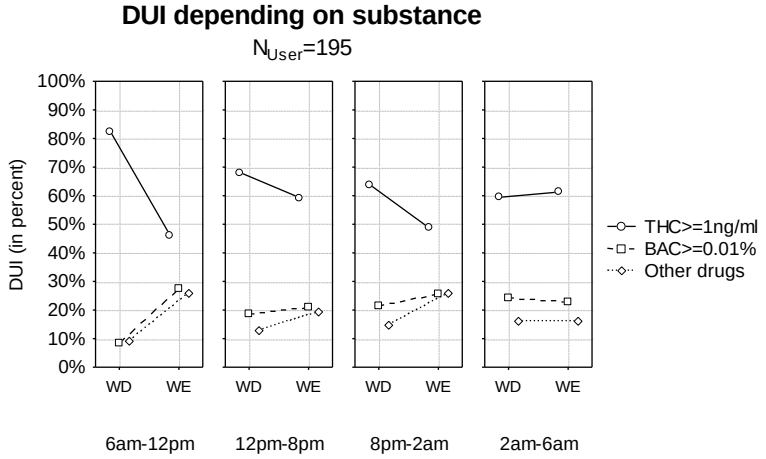


Figure 68: Percentage of DUI under different substances (THC blood plasma level≥1ng/ml, BAC≥0.01%, other substances and substance combinations) of users (N_{User}=195), depending on day of the week (WD=weekday, WE=weekend) and time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am).

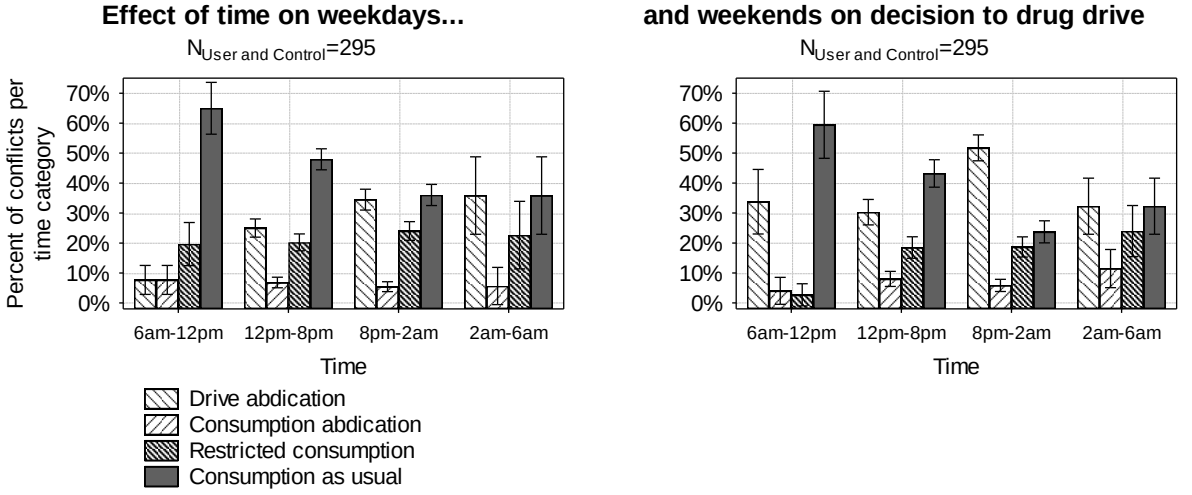
The largest amount of the users' drives under influence was under the influence of cannabis (THC blood plasma level≥1ng/ml) (Figure 68). The greatest decline of THC-positive drives between weekdays and weekends was found between 6am and noon. This could again be partly affected by residual substance concentrations from other drugs than cannabis that were consumed on weekends the night before. A markedly decrease in drives under the sole influence of cannabis on weekends compared to weekdays and the analogous increase of BAC-positive drives and especially drives under the influence of other drugs or drug combinations can also be found from 8pm-2am.

Furthermore, it can be analysed if there are any time- and day-specific differences between drives that were travelled under the influence consciously (*consumption as usual*), drives that were travelled after reduced consumption (*restricted consumption*) and trips for which the subjects stated having abdicated driving under influence by either abstaining from substance use (*consumption abdication*) or abstaining from driving (*drive abdication*: *previous consumption, later consumption*). These conditions were classified as *conflicts* – as lined out in Chapter 14.8. It is not possible to analyse these decisions for substance-specific differences because it was not asked to which substances the statements refer to.

In total, 7.8% of all subjects' trips on weekdays were conflicts – the subjects either decided against driving under influence by refraining from substance use or from driving or drove after consuming impairing substances. On weekends, 15.1% of all trips were such conflict situations. The time of the day had a clear influence on the decision to drive under influence (Figure 69).

If a conflict situation occurred between 6am and noon, the subjects decided to drive (*consumption as usual*) in around 60% of the cases, whereas later on, the proportion of refraining from driving especially increased (*drive abdication*). The proportion of trips that were travelled after *restricted consumption* or *consumption abdication* was relatively constant over time on weekdays. On weekends, the proportion of these

trips increased in time. But again, the subjects most often refrained from driving when they decided against DUI (*drive abdication*), especially from 6am until noon and from 8pm until 2am. At all other times, weekdays did not differ remarkably from weekends.



Number of conflicts within each condition (weekdays)

6am-12pm	12pm-8pm	8pm-2am	2am-6am
7% (117)	46.7% (776)	43.1% (716)	3.2% (53)

Number of conflicts within each condition (weekends)

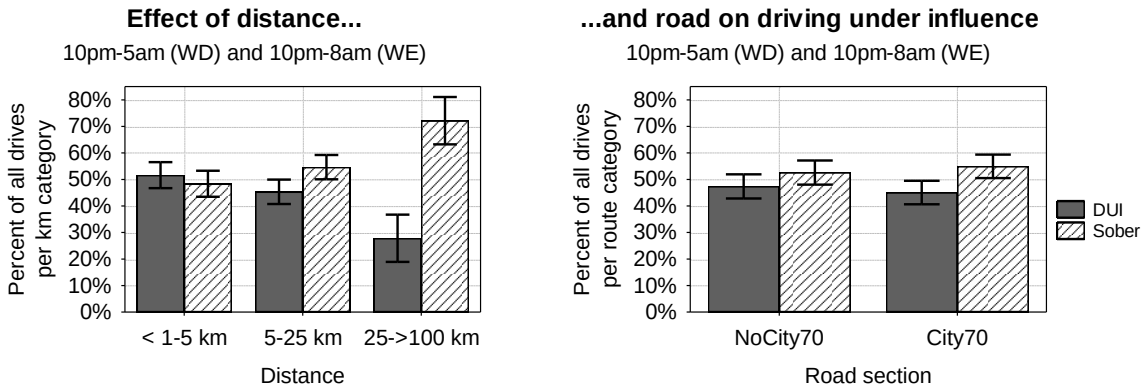
6am-12pm	12pm-8pm	8pm-2am	2am-6am
6.5% (74)	39.6% (449)	45.4% (514)	8.5% (96)

Figure 69: Effect of time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) on weekdays and weekends on the decision to drive under influence for users and controls ($N_{User\ and\ control}$=295) – percentage of conflicts per category (±0.95 CI).

14.11.2 Other situational characteristics

In this chapter, it will be analysed if companions have an influence and if there are any route specific characteristics of DUI and the decison to drive under influence.

In Chapter 14.11.1, the daily distribution of drives showed that the proportion of DUI was highest from 10pm on until approximately 5am on weekdays and until 8am on weekends. The subjects spent most of that time on leisure activities like going out or visiting friends (Chapter 14.4.2). To analyse further situational characteristics of DUI, only drives travelled in this timeframe were considered (N_{Drives}=948). Most users' drives were either shorter than five kilometres (42.1%) or five to 25 kilometres (47.7%) at that time. Only 10.2% of all drives within this timeframe were farther than 25 kilometres. The distance that was travelled as driver of a vehicle had a clear influence on the occurrence of DUI (Figure 70, left). As the distance of a drive gets longer, DUI occurred more and more rarely. For drives with a motor vehicle, the subjects stated the proportion of city roads, rural roads and motorways. All drives that covered city roads to 70% or more were classified as city trips (*City*). Drives with less than 70% city roads were classified as out of city drives (*NoCity*). 51.3% of the users' drives were city drives, 48.7% were out of city drives. The road section had no clear influence on the occurrence of DUI (Figure 70, right).



Percent (number) of drives within each km category

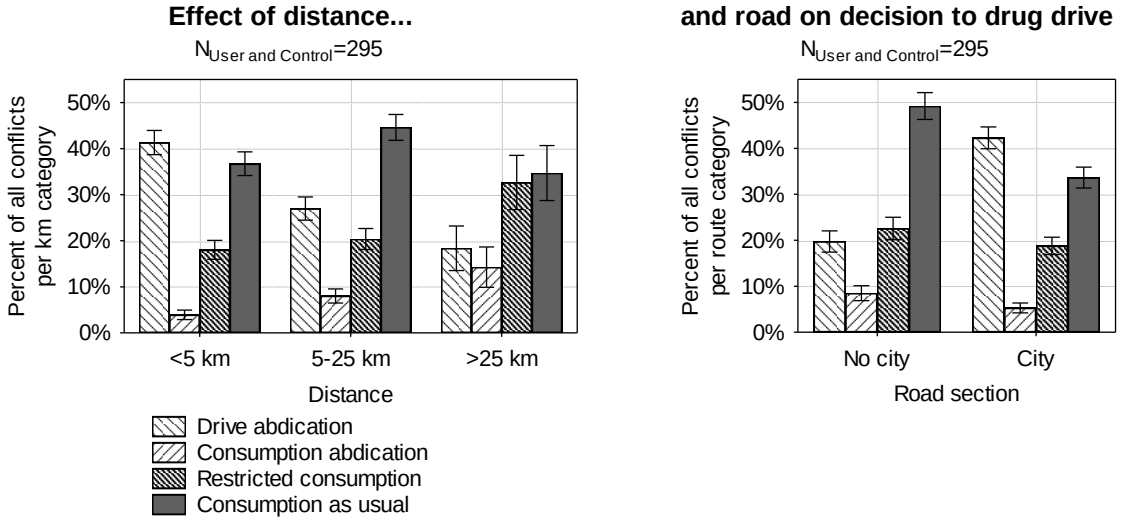
< 5 km	5-25 km	> 25 km
42.1% (399)	47.7% (452)	10.2% (97)

Percent (number) of drives within each road category

No city	City
48.7% (462)	51.3% (486)

Figure 70: Effect of distance (<5 km, 5-25 km, >25 km) and road section (no city, city) on driving under influence for users (N_{User}=195) – percentage of drives per category (±0.95 CI).

Furthermore, it was analysed if there are similar differences concerning the decision to drive under influence (Figure 71). When short trips (<5 km) were travelled (at any time of the day), 9.3% of the trips were conflicts. Of all trips of a medium distance (5-10 km), 10.4% were conflicts. Long-distance trips (>25 km) had in 9.4% of the cases a conflict involved. So, the length of the trip had no influence on the proportion of conflicts. But when short trips were travelled, the proportion of abstaining from driving (*drive abdication*) is higher than when longer trips were travelled (Figure 71, left). By contrast, the proportion of *restricted consumption* or *consumption abdication* becomes higher, the longer the covered distance was. The proportion of conscious drives under influence (*consumption as usual*) was highest for drives with a distance of five to 25 km.



Number of conflicts within each km category

< 5 km	5-25 km	> 25 km
48.4% (1,353)	42.8% (1,197)	8.8% (245)

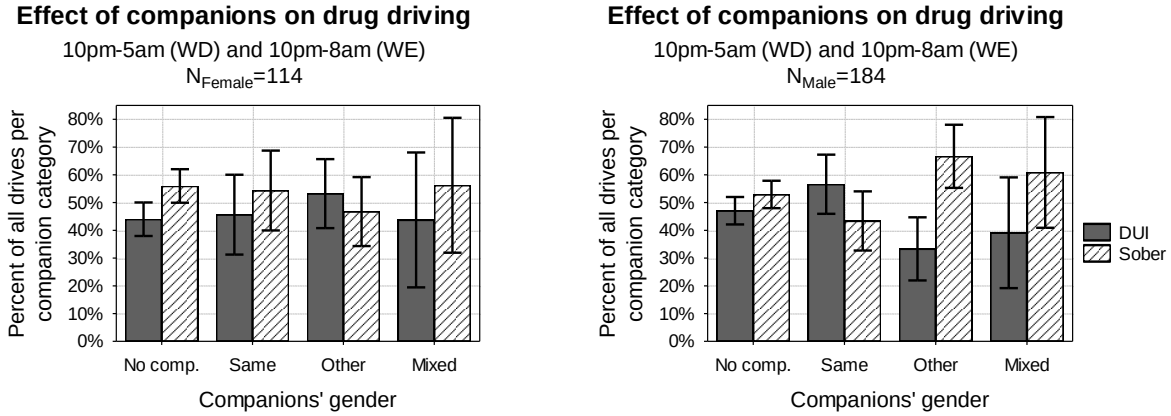
Number of conflicts within each road category

No city	City
40.4% (1,130)	59.6% (1,665)

Figure 71: Effect of distance and road section on the decision to drive under influence for users and controls ($N_{User\ and\ control}$=295) – percentage of conflicts per category (±0.95 CI).

No information was available about the proportion of the different road sections for trips that were not travelled by a motor vehicle. The distribution of all city drives and out of city drives with respect to their length indicates that drives shorter than 10 km are in 78% of the cases city drives (*City*), whereas drives of 10 km and more are in 75% of the cases out of city drives (*NoCity*). So, this kilometre classification was applied for trips for which no road section classification was available. Of the city trips, 8.5% were conflicts. When it comes to out of city trips, the percentage of conflicts of all trips was higher. Here, 12.4% of all trips were conflicts. The proportion of decisions against DUI was much smaller on out of city trips compared to city trips (Figure 71, right). Within cities, *abdication of driving* is very common, whereas the proportion of refraining from consumption (*consumption abdication*) or *restricted consumption* is marginally higher on out of city drives compared to city drives.

45.7% of the females' drives ($N_{DriveFemale}$=175) at night were under influence. For males, the percentage of drives under influence was 46.6% ($N_{DriveMale}$=263). The presence of companions had an effect on the occurrence of DUI (Figure 72). Whereas females drove marginally more often under influence than sober if male companions were accompanying, males drove less often when companions of the opposite or both genders were present. So, female companions have a preventive effect, whereas male companions increase the risk to drug drive.



Percent (number) of drives within each condition (female)

No comp.	Same	Other	Mixed
67.6% (259)	12% (46)	16.2% (62)	4.2% (16)

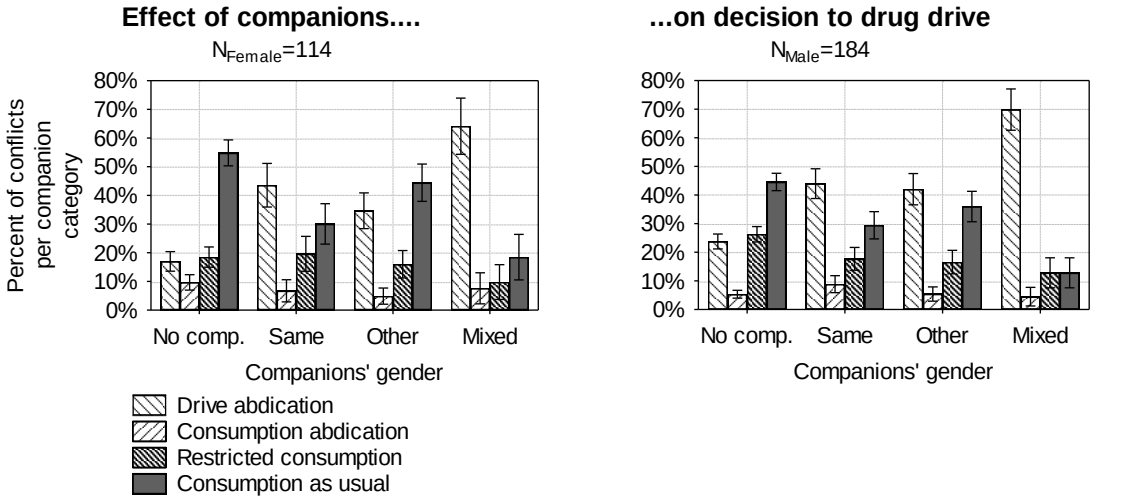
Percent (number) of drives within each condition (male)

No comp.	Same	Other	Mixed
69.6% (393)	14.7% (83)	11.7% (66)	4.1% (23)

Figure 72: Effect of companions (no companions, same gender, other gender, mixed gender) on driving under influence for females (N_{Female}=114) and males (N_{Males}=184) – percentage of drives per category (±0.95 CI).

In total, 10.6% of the males' trips were conflicts – they either decided against DUI or consciously drove under influence. Females had 8.4% of their trips stated as conflicts. Companions had an influence on the decision to drive under influence (Figure 73). If companions of mixed gender were accompanying the driver, both males and females decided more often not to drive after consumption (*drive abdication*) than to drive. They drove most often – after *restricted* or *usual consumption* – when they travelled alone, especially female subjects. If subjects were accompanied by companions of the other sex, females more often decided to drive after consumption (*consumption as usual*), whereas males more often refrained

from driving (*drive abdication*). If companions of the same gender were travelling along, no differences between male and female drivers became apparent.



Number of conflicts within each condition (female)

No comp.	Same	Other	Mixed
49.2% (465)	17.3% (163)	23.8% (225)	9.7% (92)

Number of conflicts within each condition (male)

No comp.	Same	Other	Mixed
55.7% (1,030)	18.9% (350)	17% (314)	8.4% (156)

Figure 73: Effect of companions (no companions, same gender, other gender, mixed gender) on the decision to drive under influence for females (N_{Female}=114) and males (N_{Males}=184) – percentage of conflicts per category (±0.95 CI).

14.12 Identifying persons most at risk of DUI

When considering all drives of a person, it turned out that 28 users (14.4%) and 61 controls (61%) didn't drive under influence at all (Table 53).

Table 53: Substances under which the subjects drove, number and percentage (±0.95 CI) of users (N_{User}=195) and controls ($N_{Control}$=100) who committed drives under the influence of these substances.

DUI substances	**Number of users (percent ±0.95 CI) N_{User}=195**	**Number of controls (percent ±0.95 CI) $N_{Control}$=100**
No DUI	28 (14.4%, CI: 9.5 – 19.3%)	61 (61%, CI: 51.4% - 70.6%)
BAC-positive drives	115 (59%, CI: 52.1 - 65.9%)	39 (39%, CI: 29.4% - 48.6%)
THC-positive drives	128 (65.6%, CI: 58.9 - 72.3%)	
BAC- and **THC**-positive drives	59 (30.3%, CI: 23.8 - 36.8%)	
THC-positive drives **only**	44 (22.6%, CI: 16.7 - 28.5%)	
BAC-positive drives **only**	29 (14.9%, CI: 9.9 - 19.9%)	
BAC-, **THC**- and **Stimulants**-positive drives	18 (9.2%, CI: 5.1 - 13.3%)	
BAC- and **Stimulants**-positive drives	9 (4.6%, -)	
THC- and **Stimulants**-positive drives	6 (3.1%, -)	
Stimulants-positive drives **only**	1 (0.5%, CI: -)	
THC- and **Heroin**-positive drives	1 (0.5%, CI: -)	

115 users (59%) and 39 controls (39%) drove with a positive BAC (BAC≥0.01%). 128 users (65.6%) drove after cannabis consumption. 29 users (14.9%) drove after alcohol consumption only and another 44 (22.6%) after cannabis consumption only. 59 users (30.3%) drove after consuming both. The remaining 35 users (17.9%) additionally or solely drove after consumption of other drugs or drug combinations.

Figure 74 shows the percentage of all users (N_{User}=195) and controls ($N_{Control}$=100) who committed DUI and the proportion of drives under influence for which they were responsible in descending order. In Germany, there are two BAC limits for the operation of a vehicle: zero-tolerance (for novice drivers, all drivers between the ages 18 and 21 years and newly licensed drivers of any age for the first two years of having a licence) and 0.05% (for all other drivers). Therefore, the figures show either any drive under influence, independent of the BAC (*DUI*), or drives positive for THC, stimulants, heroin and/or alcohol above the legal limit (*DUI (BAC>legal limit)*).

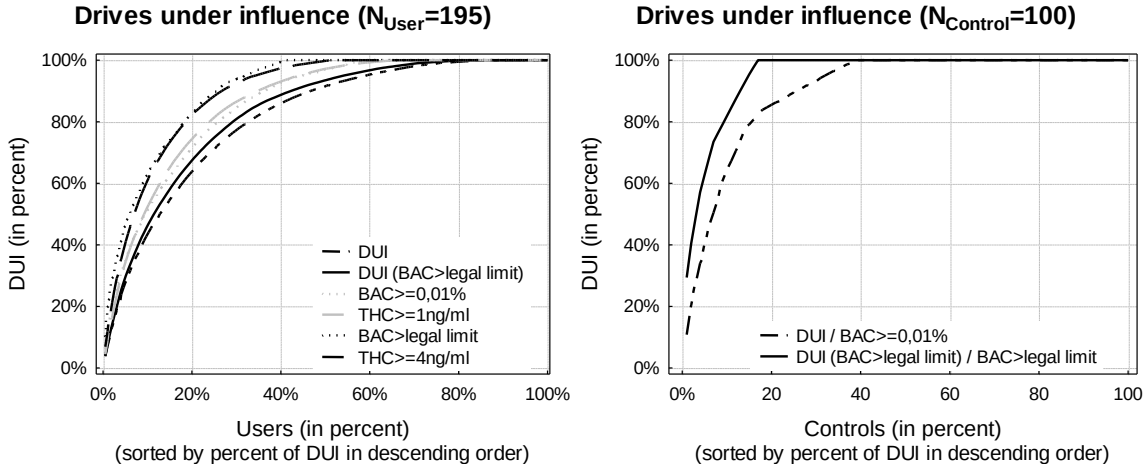


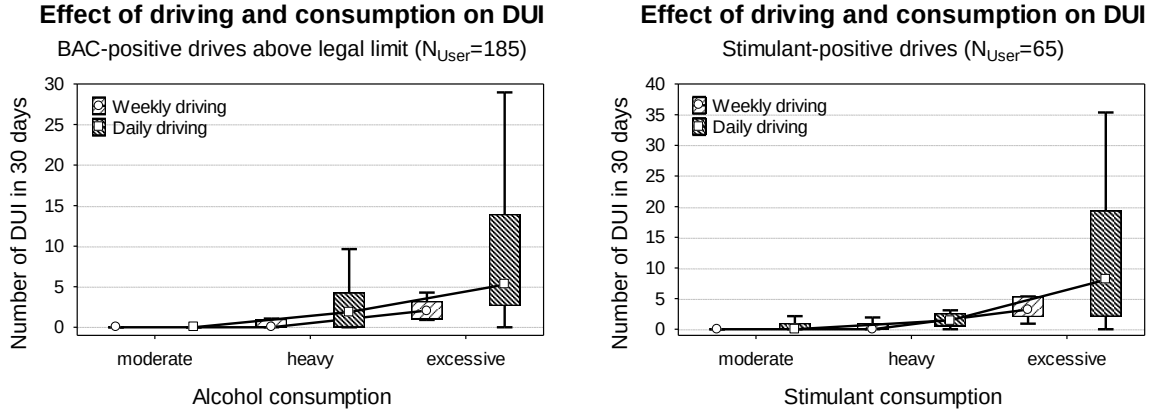
Figure 74: Percentage of DUI, depending on the percentage of users and controls who were responsible for (N_{User}=195; $N_{Control}$=100); for drives that were positive for any substance (DUI), drives that were positive for cannabis, stimulants and/or alcohol with a BAC above the legal limit (DUI (BAC>legal limit)), drives with a BAC of 0.01% and more (BAC≥0.01%), drives with a THC blood plasma level of 1ng/ml and more (THC≥1ng/ml), drives under alcohol above the legal limit (BAC>legal limit) and drives with a THC blood plasma level of 4ng/ml and more (THC≥4ng/ml).

81% (*DUI (BAC>legal limit)*) to 86% (*DUI*) of the users were responsible for all users' drives under influence (left). 28 (14%) users never drove under influence. 9 users (5%) just had drives under influence with a BAC below the legal limit. When considering drives with a BAC of 0.01% or higher or drives with a THC blood plasma level of 1ng/ml or higher, only approximately 30% of the users were responsible for around 80% of substance-positive drives (grey lines). When considering drives with a positive THC blood plasma level of 4ng/ml or higher or drives with a positive BAC above the legal limit, the number of responsible users further decreases. In these cases, up to 80% of all substance-positive drives were travelled by only 20% of the users and around 50% to 60% of the users had no substance-positive drive at all. Most controls did not drive with a positive BAC (right). 61 controls (61%) never drove under the influence of alcohol. Another 22 controls (22%) just had drives under influence with a positive BAC below the legal limit. 17 controls (17%) had drives with BACs above the legal limit. Because some controls had previously used drugs in

their life (not illustrated), the question arises if there is a correlation between previous drug use and driving under alcohol influence while participating. The 17 controls who committed alcohol-positive drives had no higher lifetime drug use compared to the remaining subjects[56].

14.13 Consumption and driving frequency

The following chapters will focus on the identification of attributes that describe those who committed DUI and those who did not. In the following, the effect of the general driving and consumption frequency on the occurrence of DUI is analysed. The consumption and driving groups classified in Chapter 14.5.3 and 14.6.3 were compared concerning their number of substance-positive drives[57]. For alcohol-positive drives, only drives that were travelled with a BAC above the legal limit were included in the analyses. Rank order tests were applied (Kruskal Wallis H-Test and Mann-Whitney U-test) to analyse the effect of different degrees of consumption and driving on the occurrence of DUI. To identify interactions between the main factors, the same procedure as described in Chapter 14.5.2 was applied.



Percent (number) of subjects in each condition (alcohol)

.	moderate	heavy	excessive
Weekly driving	15.7% (29)	18.4% (34)	4.9% (9)
Daily driving	27.6% (51)	24.9% (46)	8.6% (16)

Percent (number) of subj. in each condition (stimulants)

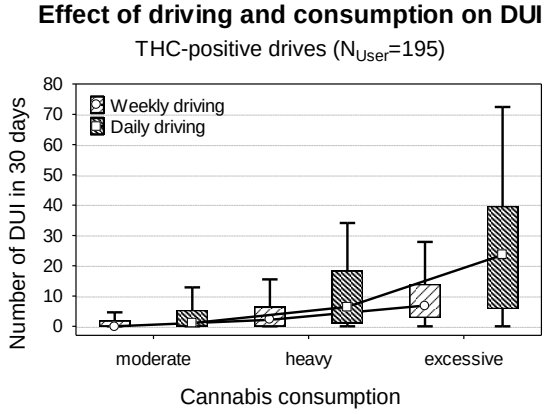
.	moderate	heavy	excessive
Weekly driving	15.4% (10)	18.5% (12)	9.2% (6)
Daily driving	24.6% (16)	12.3% (8)	20% (13)

Figure 75: Number of DUI (left figure: BAC-positive drives above legal limit; right figure: stimulants-positive drives) in 30 days (Median; 25-75%; Range without outlier) for moderate (alcohol: males >0-≤24 g/day, females >0-≤12 g/day; stimulants: >0-≤2 episodes/4 weeks), heavy (alcohol: males >24-60 g/day, females >12-40 g/day; stimulants: ≤6 episodes/4 weeks) and excessive users (alcohol: males >60 g/day, females >40 g/day; stimulants: >6 episodes/week), depending on whether they drove weekly (>0-<4 days per week) or daily (≥4 days per week).

[56] All participants gave information (Q-Start) about the number of times they had used cannabis, amphetamine, ecstasy, LSD, psilocybin, cocaine, crack, heroin, sniffing agents, and other drugs in their lifetime ("never", "1x", "2x", "3-5x", "6-9x", "10-39x", "≥40x"). For each category, the mean frequency was adopted ("never"=0x, "1x"=1x, "2x"=2x, "3-5x"=4x, "6-9x"=7x, "10-39x"=24x, "≥40x"=40x) and summed up over all drug categories. Differences in the total amount of the so calculated lifetime drug use frequency between DUI-positive controls (N=17) and all other controls (N=87) was analysed by applying the Mann-Whitney U-test. No difference was found.

[57] Because of the varying number of available reports per person, the number of drives were extrapolated to 30 days (number of drives divided by number of reported days and multiplied by 30).

The driving frequency had no effect on the occurrence of BAC-positive drives above the legal limit or on the occurrence of stimulants-positive drives (Figure 75). By contrast, the consumption frequency had a significant effect on the number of BAC- (KW-H(2;185)=51.55; p=0.000) and stimulants-positive drives (KW-H(2;65)=28.02; p=0.000), respectively. Excessive users had the most and moderate users the fewest number of substance-positive drives of all. Heavy users had a medium number of substance-positive drives. No significant interactions were found.



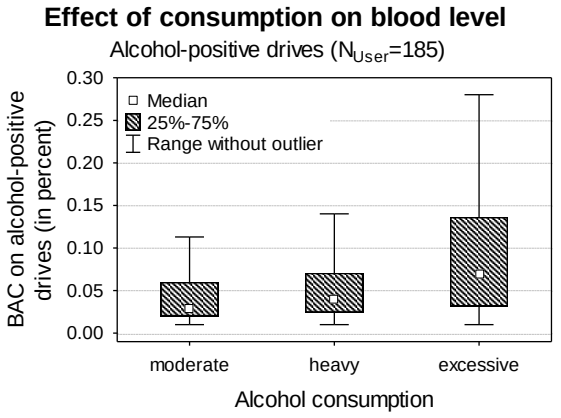
Percent (number) of subjects in each condition (cannabis)

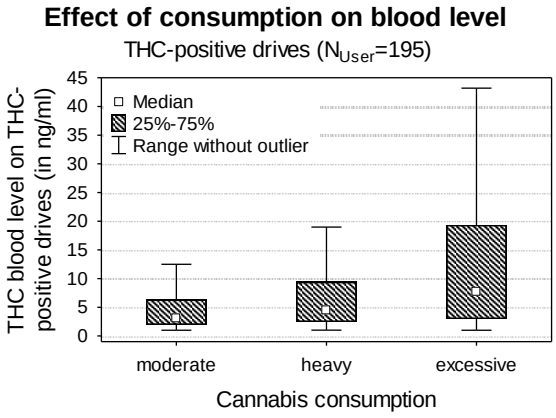
.	moderate	heavy	excessive
Weekly driving	24.1% (47)	7.7% (15)	7.2% (14)
Daily driving	29.7% (58)	15.4% (30)	15.9% (31)

Figure 76: Number of DUI (THC-positive drives) in 30 days (Median; 25-75%; Range without outlier) for moderate (>0-<1 unit/day), heavy (1-<2 units/day) and excessive users (≥2 units/day), depending on whether they drove weekly (>0-<4 days/week) or daily (≥4 days/week).

The number of THC-positive drives (Figure 76) was both influenced by the frequency of driving (MWU:Z(1;195)=4.03; p=0.000) and the frequency of cannabis consumption (KW-H(2;195)=63.60; p=0.000). Daily drivers had more THC-positive drives than those users who drove a vehicle only 1-3 days a week. Excessive cannabis users had the highest amount, heavy users a medium amount and moderate users the lowest amount of drives under the influence of cannabis. No significant interactions were found.

Furthermore, the influence of the intensity of drug use on the blood concentration level while driving was analysed. Therefore, all THC- and BAC-positive drives, respectively, were taken into account – regardless whether the driver was under the influence of alcohol or cannabis alone or in combination with another drug. Moderate, heavy and excessive alcohol and cannabis users had significantly different BACs (KW-H(2;673)=46.49; p=0.000) and THC blood plasma levels (KW-H(2;1,521)=113.03; p=0.000) on substance-positive drives, respectively (Figure 77). Excessive users had the highest (BAC: MD=0.07%; THC: MD=7.7ng/ml) and moderate users the lowest blood concentrations (BAC: MD=0.03%; THC: MD=3.2ng/ml). Heavy users had lower blood concentrations than excessive and a little higher ones than moderate users (BAC: MD=0.04%; THC: MD=4.5ng/ml).





Percent (number) of subjects in each condition (alcohol)

moderate	heavy	excessive
43.2% (80)	43.2% (80)	13.5% (25)

Percent (number) of subjects in each condition (cannabis)

moderate	heavy	excessive
53.8% (105)	23.1% (45)	23.1% (45)

Figure 77: Blood concentration on alcohol- (left) and cannabis-positive drives (right) (Median; 25-75%; Range without outlier) for moderate (alcohol: males >0-≤24 g/day, females >0-≤12 g/day; cannabis: >0-<1 unit/day), heavy (alcohol: males >24-60 g/day, females >12-40 g/day; cannabis: 1-<2 units/day) and excessive users (alcohol: males >60 g/day, females >40 g/day; cannabis: ≥2 units/day).

Besides, it was analysed if the general driving and consumption frequency has an effect on the solution strategy when facing a conflict situation, i.e. if and how one tries to avoid driving under influence. One of the users and 24 controls had no conflict situation at all while participating in the study of which nine controls drank no alcohol at all. Another control person refrained from consumption because of driving twice while participating, but did not drink alcohol and was therefore not classified as moderate, heavy or excessive user. These 26 subjects were excluded from the following analysis. To analyse whether or not the amount of substance use of the remaining subjects has an influence on the decision to drive under influence, the consumption groups concerning alcohol and cannabis were combined. The highest categorisation out of the two consumption groups was chosen for each subject. If e.g. a subject is a moderate alcohol user and an excessive cannabis user, the person was classified as excessive user. For the controls the alcohol classification was used.

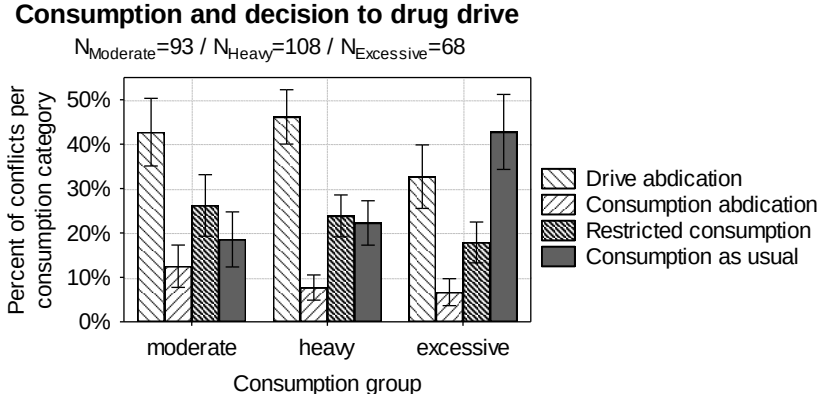


Figure 78: Effect of consumption group (moderate, heavy, excessive alcohol and/or cannabis user) on the decision to drive under influence ($N_{Moderate}$=93 / N_{Heavy}=108 / $N_{Excessive}$=68) – mean percentage of conflicts per category (±0.95 CI).

In general, excessive users had the most conflict situations of all and moderate users the fewest[58]. The consumption group had a clear effect on the decision to drive after drug consumption (Figure 78). The highest proportion of conscious drives under influence was found for excessive users (*consumption as usual*). They also least often refrained from driving (*drive abdication*) after they had consumed drugs and less often *restricted* or *abdicated consumption*. The proportions of heavy and moderate users do not differ much. Moderate users seem to more often *abdicate consumption*.

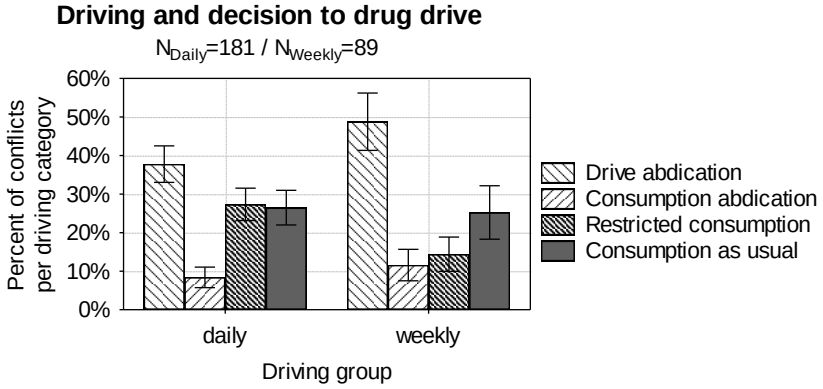


Figure 79: Effect of driving group (daily, weekly) on the decision to drive under influence (N_{Daily}=181 / N_{Weekly}=89) – mean percentage of conflicts per category (±0.95 CI).

Daily drivers had slightly more conflict situations than weekly drivers. But this difference didn't reach significance (MWU: Z(1;295)=1.74; p=0.081). Daily and weekly drivers did not differ in their proportion of driving after drug consumption in conflict situations (*consumption as usual*) (Figure 79). However, they differed in their proportion of *abdicating driving*. Daily drivers abdicated driving less often compared to weekly drivers, yet they *restricted consumption* more often than weekly drivers.

Thus, both the driving and consumption frequency have an influence on the occurrence of DUI and affect the way that someone decides against DUI. Besides, a high intensity of substance use is associated with a high median substance blood concentration while driving.

Furthermore, a more precise description of the consumption pattern of users shall be given. The analysis is conducted for the use of illegal substances and of alcohol. The proportion of hours with substance use on weekends compared to weekdays[59] and the proportion of hours with substance use in the evenings/at nights compared to at daytime[60] was calculated per person and dichotomised by median-split. The median proportion of drug use on weekends is 41.4% (34.5-48.3%). The median proportion

[58] Excessive-moderate: MWU: Z(1;177)=8.91; p=0.000; excessive-heavy: MWU: Z(1;177)=4.02; p=0.000; moderate-heavy: MWU: Z(1;216)=7.68; p=0.000 (For this calculation, the subjects who had no conflict situation were included in the analysis with a value of zero; because of the varying number of available reports per person, the number of conflicts was extrapolated to 30 days).
[59] Weekend: all reported hours after 8:31pm on Fridays until 8:30pm on Sundays; Weekday: all remaining hours.
[60] Evening/night: all reported hours from 5:31pm until 5:30am; daytime: all remaining hours.

of drug use in the evenings/at nights is 84.3% (79.2-89.4%). From this categorisation, a contingency table was created (Table 54). It is hypothesised that users who mostly use drugs on weekends and mostly at night have the lowest proportion of DUI. The influence of the time of day is thought to be higher than the influence of the day of week. So, the proportion of drives under influence is supposed to increase according to the numbers of the different categories (1-4).

Table 54: Consumption pattern: contingency table of the variables day of the week (high proportion of substance use on weekends, low proportion of substance use on weekends) and time (high proportion of substance use in the evening/at night, low proportion of substance use in the evening/at night).

Consumption – Time and day of the week		Weekend	
		High proportion	Low proportion
Evening/night	High proportion	1) Mostly on weekends and mostly at night	2) Often on weekdays and mostly at night
	Low proportion	3) Mostly on weekends and often during the day	4) Often on weekdays and often during the day

Figure 80 (left) shows the median proportion of drives under influence of illegal drugs for the categories 1-4. If users consume illegal drugs mostly on weekends and mostly at night (Category 1), they hardly ever commit DUI. The same holds true for those users who also use drugs often on weekdays but still mostly at night (Category 2). The highest proportion of DUI was found for users who have a relative high proportion of drug use on weekdays and during the day (Category 4), followed by those who consume drugs mostly on weekends, but relatively often during the day (Category 3). The correlation of the proportion of drug use on weekends and the proportion of drug use in the evening/at night, respectively, with the proportion of DUI, results in a low negative correlation for the former (r=-0.2) and a medium negative correlation for the latter (r=-0.6).

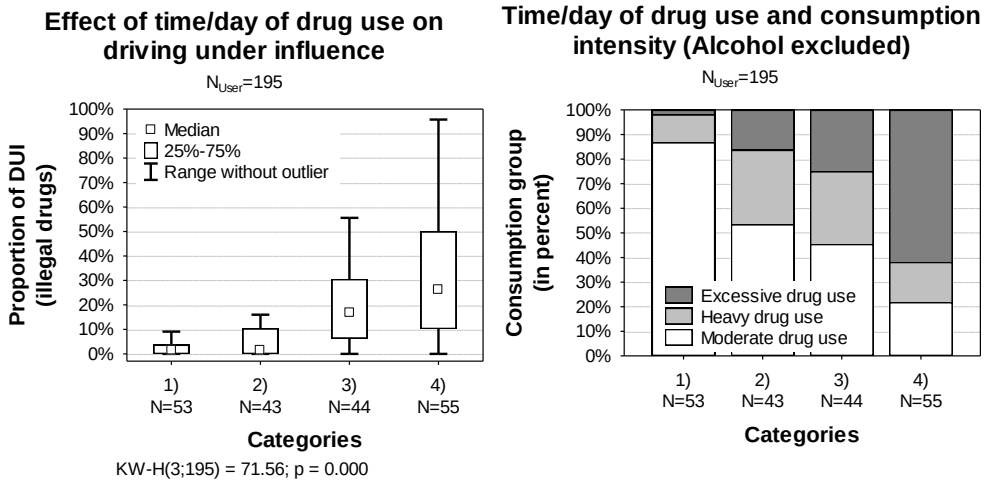


Figure 80: Effect of time/day of consumption on the proportion of drives under influence of illegal drugs of all drives (left; median, 25%-75%) and relation of time/day of consumption and consumption intensity (right; excessive drug use: ≥2 units per day, heavy drug use: ≥1-2 units per day, moderate drug use:<1 unit per day) (N_{User}=195).

The group of users who restrict their consumption to weekends and evenings/nights (Category 1) makes up the greatest part of moderate drug users[61] (86.8%) (Figure 80, right). Quite a high proportion of excessive drug users (61.8%) can be found within the group of users who also use drugs during the day and during the week (Category 4). In the remaining two categories the proportion of heavy drug users is quite high (Category 2: 30.2%, Category 3: 29.5%).

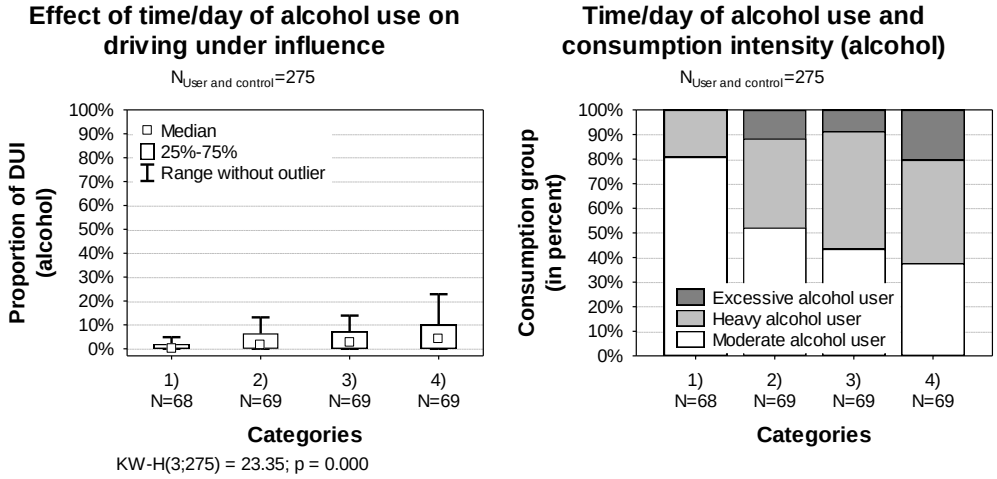


Figure 81: Effect of time/day of consumption on the proportion of drives under influence of alcohol of all drives (left, Median, 25%-75%) and relation of time/day of consumption and consumption intensity (right; excessive alcohol use: >60 g/day (male), >40 g/day (female); heavy alcohol use: >24-60 g/day (male), >12-40 g/day (female); moderate alcohol use: >0-≤24 g/day (male), >0-≤12 g/day (female)) ($N_{User\ and\ control}$=275).

The median proportion of alcohol use on weekends is 53% (47.1-58.9%). The median proportion of alcohol use in the evenings/at nights is 92% (88.8-95.2%). Compared to cannabis use, alcohol use is more restricted to evenings/nights and weekends. Figure 81 (left) shows the median proportion of drives under influence of alcohol for the categories 1-4. The effect of time of alcohol use (evening/night versus daytime) and day of alcohol use (weekday versus weekend) on the proportion of drives under alcohol influence is not as profound as for cannabis. Nevertheless, the effect is significant. The lowest proportion of drives under the influence of alcohol was found for users who consume alcohol mostly on weekends and mostly at night (Category 1). The highest proportion of DUI was found for users who often drink alcohol on weekdays and during the day (Category 4), followed by those who drink alcohol mostly on weekends, but often during the day (Category 3) and those who drink alcohol often on weekdays and mostly at night (Category 2). The correlation of the proportion of alcohol consumption on weekends and the proportion of alcohol consumption in the evening/at night, respectively, with the proportion of DUI results in low negative correlations (r=-0.2). So, compared to cannabis use, the time of alcohol use has a less profound influence on the frequency of DUI, while the influence of the day of substance use is comparable. The group of users who restrict their consumption to weekends and evenings/nights (Category 1) consists to 100% of

[61] Use of illegal drugs and/or misuse of prescription medicines (Alcohol excluded).

moderate (86.8%) and heavy users (13.2%) (Figure 81, right). In the remaining categories, the proportion of moderate alcohol users decreases (Category 2: 52.2%, category 3: 43.5%, category 4: 37.7%), whereas the proportion of heavy and excessive users increases (Category 2: 47.8%, category 3: 56.5%, category 4: 62.3%).

14.14 Other traffic related conspicuousness

14.14.1 Records in the Central Register of Traffic Offenders

Road users who have become conspicuous in road traffic are recorded in the Central Register of Traffic Offenders (for more information: http://www.kba.de). In the Central Register of Traffic Offenders, final and legally binding decisions are recorded for a certain period of time based on:

- **Driving licence authorities** (approx. 650 nationwide), which refuse, withdraw or newly grant driving licences (including other measures, like ordered or voluntary participation in a rehabilitation programme, to lower the number of demerit points),
- **Authorities that impose fines, demerit points or driving bans** to punish administrative offences,
- **Courts**, which pass a sentence due to criminal offences associated with road traffic.

275 subjects gave a written consent to access their records at the Central Register of Traffic Offenders. 20 subjects, all users, did not agree to the accessing of their records. 118 users (67.4%) had no reported decisions in the file at all. Of the controls, 80 subjects (80%) were not recorded in the register. 57 users (32.6%) had, in total, 146 reported decisions (MD=2; Q25=1; Q75=3). 20 controls (20%) had, in total, 42 reported decisions (MD=1; Q25=1; Q75=1,5). When considering all subjects, not only those who were indeed registered, it got apparent that users in general have more reported decisions than controls (MWU: $Z(1;275)=2.65$; $p=0.008$). When excluding records that are linked to DUI offences, this difference disappears.

Most reported decisions (44.7%) did not involve any disciplinary action (e.g. driving ban, rehabilitation programme, Table 55) but refer to offences that were exclusively punished by demerit points (and fines, see also Table 56). A great part of the reported decisions that refer to disciplinary actions refer to driving bans (13.8%), the voluntary participation in a rehabilitation programme (11.7%) or orders to participate in a rehabilitation programme (9%). The remaining decisions refer to driver licence reinstatements (5.9%), licence withdrawal (permanent or temporary; 4.3%), voluntary relinquishments of the licence within a withdrawal procedure (4.3%), warnings and advice to participate in a rehabilitation programme (3.7%) or psychological counselling (1.6%), licence ban (0.5%) and licence confiscation (0.5%). Most decisions that were reported for the controls (66.7%) do not refer to any disciplinary action, whereas a large part of the users' decisions refer to driving bans (17.1%), orders to participate in a rehabilitation programme (10.3%), driver licence reinstatements (6.9%), licence withdrawal (4.1%) and voluntary relinquishment of the

licence in the course of a withdrawal procedure (5.5%). Both users and controls had a large proportion of reported decisions concerning the voluntary participation in a rehabilitation programme (users: 12.3%; controls: 9.5%).

Table 55: Recorded decisions in the Central Register of Traffic Offenders for users (N_{User}=57) and controls ($N_{Control}$=20).

Decisions in the Central Register of Traffic Offenders	**User N_{User}=57**	**Control $N_{Control}$=20**	**Total**
No disciplinary action	56 (38.4%)	28 (66.7%)	84 (44.7%)
Driving ban	25 (17.1%)	1 (2.4%)	26 (13.8%)
Voluntary participation in a rehabilitation programme	18 (12.3%)	4 (9.5%)	22 (11.7%)
Order to participate in a rehabilitation programme	15 (10.3%)	2 (4.8%)	17 (9%)
Driver licence reinstatements	10 (6.9%)	1 (2.4%)	11 (5.9%)
Licence withdrawal (permanent)	6 (4.1%)	1 (2.4%)	7 (3.7%)
Licence withdrawal (temporary)	0 (0%)	1 (2.4%)	1 (0.5%)
Voluntary relinquishment of licence within withdrawal procedure	8 (5.5%)	0 (0%)	8 (4.3%)
Warnings and advice to participate in a rehabilitation programme	5 (3.4%)	2 (4.8%)	7 (3.7%)
Warnings and advice to participate psychological counselling	1 (0.7%)	2 (4.8%)	3 (1.6%)
Licence ban	1 (0.7%)	0 (0%)	1 (0.5%)
Licence confiscation	1 (0.7%)	0 (0%)	1 (0.5%)
Total	146 (100%)	42 (100%)	188 (100%)

Table 56: Recorded offences in the Central Register of Traffic Offenders for users (N_{User}=49) and controls ($N_{Control}$=18) that were punished by demerit points ($N_{OffenceUser}$=84; $N_{OffenceControl}$=29) and partly connected to a disciplinary action, like driving ban, withdrawal, etc. (user=33.3%; control=3.4%).

Recorded offences in the Central Register of Traffic Offenders		**User N_{User}=49**	**Control $N_{Control}$=18**	**Total**
Illegal drugs	Administrative	4 (4.8%)		4 (3.5%)
	Criminal	1 (1.2%)		1 (0.9%)
Alcohol	Administrative	4 (4.8%)		4 (3.5%)
	Criminal	5 (6%)		5 (4.4%)
Other administrative offences				
Speeding		39 (46.4%)	19 (65.5%)	58 (51.3%)
Red traffic light		9 (10.7%)	1 (3.4%)	10 (8.8%)
Right of way		3 (3.6%)		3 (2.7%)
Safety gab		1 (1.2%)		1 (0.9%)
Overtaking		1 (1.2%)		1 (0.9%)
Turning, backing up			1 (3.4%)	1 (0.9%)
General inspection			1 (3.4%)	1 (0.9%)
Driving in spite of ban because of smog		1 (1.2%)		1 (0.9%)
Other administrative offences		1 (1.2%)	2 (6.9%)	3 (2.7%)
Other administrative offences (probationary licence)		10 (11.9%)	4 (13.8%)	14 (12.4%)
Other criminal offences				
Driving without licence		2 (2.4%)	1 (3.4%)	3 (2.7%)
Injury		1 (1.2%)		1 (0.9%)
Driving with uninsured vehicle		1 (1.2%)		1 (0.9%)
Other criminal offences (probationary licence)		1 (1.2%)		1 (0.9%)
Total		84 (100%)	29 (100%)	113 (100%)

For some subjects (N_{User}=8, $N_{Control}$=2), exclusively disciplinary actions were registered. The corresponding offences were already erased. So, 49 users had, in total, 84 recorded offences that were punished by demerit points (i.e. 28% of all users for whom the data was available). Five of the users' offences were related to driving under the influence of illegal drugs (administrative offence: 4.8%, criminal offence: 1.2%) and nine to drink driving (administrative offence: 4.8%, criminal offence: 6%; Table 56). 30-39-year-olds and subjects from urban/city areas especially had offences due to DUI[62]. 29 offences that were punished by demerit points were committed by 18 controls (i.e. 18% of all controls). None of them were offences regarding DUI. Many subjects, regardless whether user or control, committed offences regarding speeding (51.3%) and not further specified administrative offences during the probationary period (12.4%). The users also often drove through red lights (10.7%).

By including subjects who had no offences registered with a value of zero in the analyses, the calculation results in a higher number of offences for users as compared to controls (MWU: Z(1;275)=1.98; p=0.048). The absolute number of recorded offences did not differ between users and controls when DUI offences were excluded or only those subjects were included in the analysis who had at least one offence registered.

Table 57: Number of demerit points of users (N_{User}=175) and controls ($N_{Control}$=100).

				Demerit points					
DUI substance		**Inclusion**	**$N_{Subject}$**	**MD**	**$Q_{.05}$**	**$Q_{.25}$**	**$Q_{.75}$**	**$Q_{.95}$**	**MAX**
Users	**DUI included**	**All**	**175**	**0**	0	0	1	8	15
		>0 point	**49**	**4**	1	3	7	11	15
	DUI excluded	**All**	**175**	**0**	0	0	0	6	15
		>0 point	**43**	**3**	0	1	5	9	15
Controls		**All**	**100**	**0**	0	0	0	3	15
		>0 point	**18**	**1,5**	1	1	3	15	15

Users have more demerit points than controls (Table 57), but only if the points due to DUI offences are included (MWU: Z(1;275)=2.31; p=0.021). When only considering subjects who had at least one point, users always had a higher number of recorded demerit points than controls, regardless whether DUI offences were included (MWU: Z(1;67)=3.27; p=0.001) or excluded (MWU: Z(1;61)=2.60; p=0.009).

Subjects who became conspicuous in traffic before (any decision registered in the file) did not commit more DUI while participating in the study than subjects who did not become conspicuous before. When the subjects who had at least one demerit point recorded in the file were compared with subjects who had no points, a slight effect became apparent for the controls (MWU(1;100)=2.23; p=0.026; Figure 82). Controls who had demerit points drove slightly more often with a BAC above the legal limit. The effect was very small (controls with points: MD=0; Q25=0; Q75=1.07; controls without points: MD=0; Q25=0; Q75=0). Users with demerit points had no

[62] $N_{DUIOffenders}$=14:
8.8% (N=10) of males, 6.5% (N=4) of females (chi^2=0.32, df=1, p=0.570);
6.7% (N=10) of 18-29-year-olds, 16% (N=4) of 30-39-year-olds (chi^2=2.11, df=1, p=0.147);
3.9% (N=3) of rural subjects, 11.1% (N=11) of urban/city subjects (chi^2=3.23, df=1, p=0.072).

significantly differing number of drives under influence than users who had no points (whether or not demerit points due to DUI were regarded).

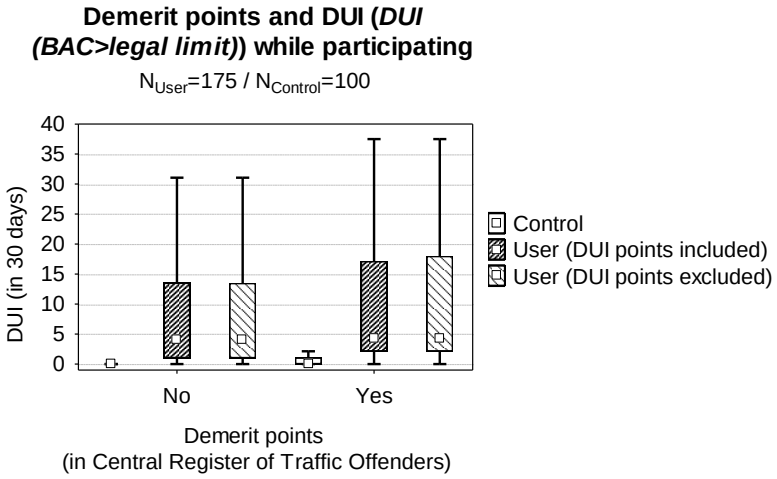


Figure 82: Number of drives under influence in 30 days (DUI (BAC>legal limit)), depending on whether or not demerit points were recorded in the Central Register of Traffic Offenders (no, yes) for users (N_{User}=175) and controls ($N_{Control}$=100) – in the case of users, demerit points caused by DUI are either included or excluded (Median, 25%-75%, Range without outlier).

Those users who had demerit points due to DUI did not have a significantly different amount of drives under influence while participating in the study compared to those users who had no DUI demerit points recorded in the register (Figure 83).

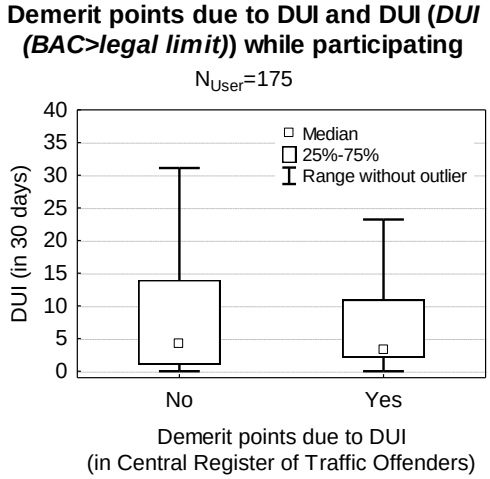


Figure 83: Number of drives under influence in 30 days (DUI (BAC>legal limit)), depending on whether or not the subjects had demerit points due to a DUI offence (N_{User}=175; Median, 25%-75%, Range without outlier).

Decisions that are recorded in the Central Register of Traffic Offenders cover disciplinary actions and all administrative and criminal offences that road traffic users have committed. In general, users had more decisions and more offences that were reported in the file. When excluding decisions and offences due to DUI, this predominance disappears. 14 users had become conspicuous in road traffic because

of DUI. Controls had no recorded DUI offences in the register. In general, users received more demerit points. But again, the difference diminishes as soon as demerit points due to DUI were excluded from the analysis. When only those subjects were analysed who have demerit points recorded in the register, it turned out that users have a higher number of points, regardless whether or not DUI offences are in- or excluded. So, the users' offences are in general punished by more demerit points than the controls' (e.g. higher speeding, running a red light). Subjects who were previously conspicuous in road traffic and registered in the Central Register of Traffic Offenders did not commit more drives under influence of illegal drugs and/or drives with a BAC above the legal limit while participating in the study. The 14 users who had a DUI offence reported in the file did not commit more DUI within the study period in comparison to those who were not conspicuous with respect to previous drug driving. So, in total, except from offences concerning drug driving, users were not more often conspicuous in road traffic than controls. However, users who were recorded in the file had committed more severe offences than controls (as they were punished by more demerit points).

14.14.2 Dangerous traffic situations

For 1.2% (N=181) of all drives that were travelled as driver of a vehicle, the subjects stated that a dangerous traffic situation occurred while driving. In this cases, the subjects were queried about what exactly happened and it was decided from the course of the story if the subject was culpable for the situation or not.

The users stated 109 dangerous traffic situations while driving (1.1% of the users' drives). 89 were sober drives (81.6%), 20 were under influence (18.4%). In 44 of the cases (40.4%), the subjects were culpable. In 59 of the cases (54.1%), they were not culpable. In 6 of the cases (5.5%), no in-depth interview was conducted. The controls stated 72 dangerous traffic situations while driving (1.3% of the controls' drives). All were sober drives (100%). In 33 of the cases (45.8%), the controls were culpable. In 34 of the cases (47.2%), they were not culpable. In 5 of the cases (7%), no in-depth interview was conducted.

Table 58: Absolute number of dangerous traffic situations (N_{Total}=181) per substance and study group (N_{User}=195; $N_{Control}$=100) and absolute number of sober drives, odds ratios, corresponding statistics.

Substance			No danger	Danger	OR	Chi squared	p-level
BAC	≥0.01%	User	405	5	1.02	0.00	0.963
		Control	127	0			
	≥0.05%	User	208	3	1.19	0.09	0.764
	≥0.11%	User	81	1	1.02	0.00	0.983
THC	≥1ng/ml		1,342	12	0.74	0.96	0.328
	≥4ng/ml		814	8	0.81	0.31	0.577
	≥10ng/ml		446	3	0.56	1.02	0.313
BAC≥0.01% & THC≥1ng/ml			106	1	0.78	0.06	0.806
Stimulants			146	1	0.57	0.33	0.569
Other			80	1	1.03	0. 001	0.973
Sober		User	7,365	89			
		Control	5,447	72			

To estimate the risk of having a dangerous traffic situation when driving under influence, odds ratios were calculated (Table 58). The risk of having a dangerous traffic situation when driving under the influence of alcohol (BAC≥0.01%, BAC≥0.05%, BAC≥0.11%), cannabis (THC≥1ng/ml, THC≥4ng/ml, THC≥10ng/ml), alcohol and cannabis (BAC≥0.01% and THC≥1ng/ml), stimulants or substance combinations other than alcohol and cannabis is not increased. The corresponding chi squares did not reach significance.

Table 59: Absolute number of dangerous traffic situations (N_{Total}=170) per substance and absolute number of sober drives per study group (N_{User}=195; $N_{Control}$=100), separated for culpability ($N_{Culpable}$=77), odds ratios, corresponding statistics.

Substance			Not culpable	Culpable	OR	Chi squared	p-level
BAC	≥0.01%	User	3	2	0.98	0.00	0.983
		Control	0	0			
	≥0.05%	User	1	2	2.94	0.82	0.365
	≥0.11%	User	1	0			
THC	≥1ng/ml		6	5	1.23	0.10	0.752
	≥4ng/ml		4	3	1.10	0.02	0.902
	≥10ng/ml		2	0			
BAC≥0.01% & THC≥1ng/ml			0	1			
Stimulants			0	1			
Other			0	1			
Sober		User	50	34			
		Control	34	33			

The same procedure was applied to estimate the risk of being culpable for a dangerous traffic situation when driving under influence (Table 59). The risk of being culpable for a dangerous traffic situation when driving under the influence of alcohol (BAC≥0.01%, BAC≥0.05%, BAC≥0.11%), cannabis (THC≥1ng/ml, THC≥4ng/ml, THC≥10ng/ml), alcohol and cannabis (BAC≥0.01% and THC≥1ng/ml), stimulants or substance combinations other than alcohol and cannabis is not increased. The corresponding chi squares did not reach significance.

Table 60: Individual number of self-inflicted dangerous traffic situations (culpable) and number and percentage of users (N_{User}=195) and controls ($N_{Control}$=100) who were responsible for.

Culpable	User		Control		Total	
$N_{Dangerous\ traffic\ situations}$	$N_{Subjects}$	%	$N_{Subjects}$	%	$N_{Subjects}$	%
0	158	81%	73	73%	231	78.3%
1	30	15.4%	23	23%	53	18%
2	7	3.6%	3	3%	10	3.4%
4	0	0%	1	1%	1	0.3%

Of the users, 158 subjects (81%) had no dangerous traffic situation that they were responsible for. 30 users (15.4%) had one and 7 (3.6%) had two such occasions. Of the controls, 73 subjects (73%) had no dangerous traffic situations that they were responsible for, 23 (23%) had one, 3 (3%) had two and one control subject (1%) had four such incidences (Table 60). It was analysed if those who had at least one dangerous traffic situation that was caused by the subjects' own fault, committed more drives under the influence of illegal substances and/or a BAC above the legal

limit while participating in the study as compared to subjects who had no dangerous traffic situation that they were responsible for (Figure 84).

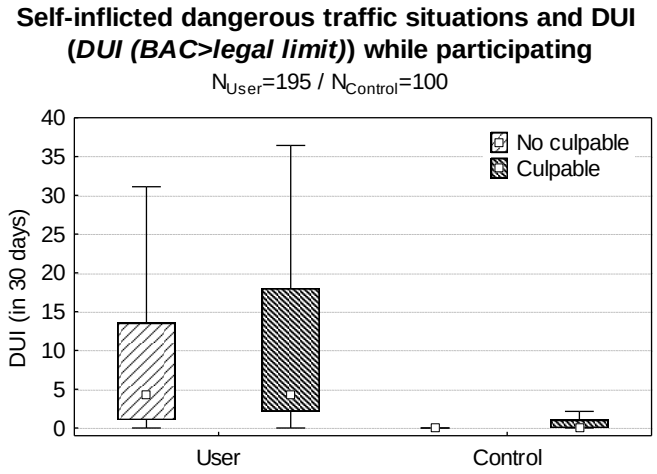


Figure 84: Number of drives under influence in 30 days (DUI (BAC>legal limit)) for users (N_{User}=195) and controls ($N_{Control}$=100), depending on whether or not the subjects had at least one dangerous traffic situation that they were responsible for (Median, 25%-75%, Range without outlier).

For controls, the difference reached significance (MWU: Z(1;100)=2.49; p=0.013). The effect was very small (culpable controls: MD=0; Q25=0; Q75=1.03; No culpable controls: MD=0; Q25=0; Q75=0). Users who had at least one self-inflicted dangerous traffic situation did not commit more DUI as compared to those users who had no self-inflicted dangerous traffic episode.

The calculated odds ratios that describe the risk of having a dangerous traffic situation or being culpable in the case of a dangerous traffic situation suggest no increased risk for driving under influence. Subjects who were culpable for a dangerous traffic situation while participating in the study were not also conspicuous by an increased frequency of DUI.

14.15 Person-related characteristics of DUI

14.15.1 Gender, age and residence

To analyse the effect of gender, age and residence, the number of drives under influence (BAC≥0.01%, BAC≥0.05%, THC≥1ng/ml, THC≥4ng/ml, stimulants-positive) in 30 days for the different levels of the variables were compared by using rank order tests (Kruskal Wallis H-Test and Mann-Whitney U-test). To find out if interactions existed, the same procedure as described in Chapter 14.5.2 was applied. Significant differences were found for age and residence (Table 61). 18-24-year-olds and 25-29-year-olds drove more often under the influence of cannabis when it came to THC blood plasma levels of 4ng/ml or higher compared to 30-39-year-olds. Subjects from urban areas drove less often under the influence of cannabis (THC≥1ng/ml,

THC≥4ng/ml) than subjects from rural or city areas. Interactions between the factors gender, age and residence turned out to be not significant.

Table 61: Significant effects of gender, age and residence on occurrence of substance-positive drives in 30 days (N_{User}=195).

	Gender	Age	Residence
BAC≥0.01%			
BAC≥0.05%			
THC≥1ng/ml			rural > urban Z(1;149)=4.35; p=0.000 city > urban Z(1;114)=3.39; p=0.000
THC≥4ng/ml		18-24 > 30-39 Z(1;145)=2.32; p=0.020 25-29 > 30-39 Z(1;78)=2.18; p=0.029	rural > urban Z(1;149)=4.66; p=0.000 city > urban Z(1;114)=3.13; p=0.002
Stimulants			

14.15.2 Mental diseases

To get information about the subjects' psychological problems, the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; Substance Use Disorders, Anxiety Disorders, Eating Disorders, Mood Disorders, Somatoform Disorders, Psychotic Disorders and Adjustment Disorder) was conducted (Wittchen et al., 1997). The DSM-IV is the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (APA, 1994). Furthermore, information about any past or current diagnosis of Attention Deficit and Hyperactivity Disorder (AD(H)D) or Borderline Personality Disorder was received by the subjects.

14.15.2.1 Overview

Figure 85 shows the lifetime prevalences of the main mental disorders that were estimated from the study sample compared with prevalences derived from other studies (MFS, NEMESIS, cited in Meyer, Rumpf, Hapke, Dilling, & John, 2000; Tacos, Meyer et al., 2000). To account for differences due to gender and study group, the prevalences for males and females within the present sample were averaged per study group and then multiplied by the proportion of users and controls, respectively, within the 18-39-year-old German population[63]. Then, the two calculated values (proportion of users' and controls' prevalence) were added. Almost all prevalences, which were estimated like this, were higher than those of the three other studies. Three possible explanations can be suggested for this discrepancy:

(1) Age and Time-effect: All other studies queried persons up to an age of 64/65 10 to 20 years ago. The sample of the present study comprises of subjects who are aged 18 to 39 at present. According to Kessler et al. (2005), the lifetime prevalences of mental disorders are higher in recent than in earlier cohorts.

[63] Prevalence of users (inclusion criteria: regular drug use, i.e. more than three times in four weeks) within the 18-39-year-old German population: 2.8%; prevalence of controls: 97.8%.

(2) Setting-effect: Within the present study, particular attention was paid to maintain a good relationship with the subjects by in-depth face-to-face survey sessions. The setting was not a conventional clinical setting. Thus, the subjects might have talked more freely about their problems compared to more anonymous settings. Therefore, a bias against reporting embarrassing behaviours that was reported by Cannell (cited in Kessler et al., 2005) might be rather low in the present context.

(3) Population-effect. All other studies drew their samples by random sampling (N_{MFS}=483; $M_{NEMESIS}$=7,076; N_{Tacos}=4,075). The present study recruited the subjects by media campaigns and word-of-mouth-recommendations (N_{GSS}=295). Thus, the sample could selectively consist of people who are more interested in psychological research. This, in turn, could be due to a higher proportion of psychological problems within the sample than on average.

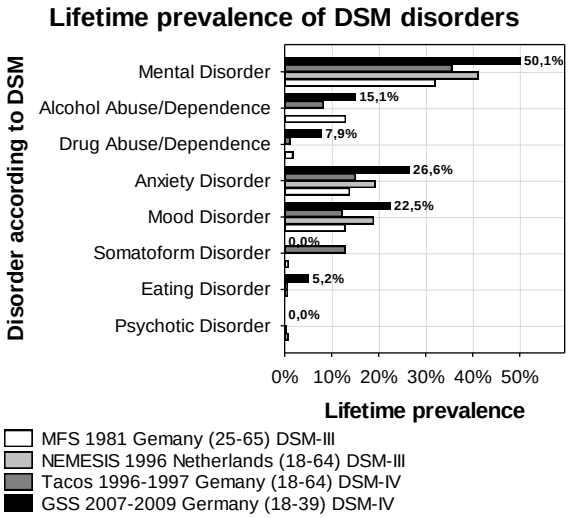


Figure 85: Lifetime prevalence estimates for major mental disorders by the present study (GSS 2007-2009) compared to other studies (MFS 1981, NEMESIS 1996, Tacos 1996-1997).

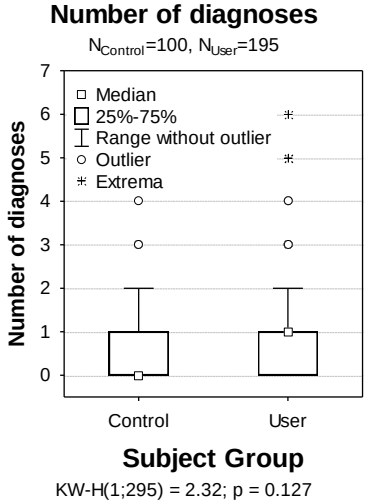


Figure 86: Median of number of diagnoses for users (N_{User}=195) and controls ($N_{Control}$=100) (Substance Use Disorders excluded; 25%-75%, Range without outlier, Outlier, Extrema).

Table 62: Mental disorders (main categories and sub-categories) that were queried, prevalence within user (N_{User}=195) and control group ($N_{Control}$=100) (in percent, ±0.95 CI) and statistics.

Category	User	Control	chi-square (df=1)	p-value
Alcohol-use Disorders	**Percent (±0.95 CI)**	**Percent (±0.95 CI)**		
Alcohol Abuse	29.2% (22.8-35.6)	9% (3.4-14.6)	**17.49**	**0.000**
Alcohol Dependence	20.5 (14.8-26.2)	6% (1.3-10.7)	**12.1**	**0.001**
Drug use Disorders				
Drug Abuse	33.8% (27.2-40.5%)	3% (-)	**44.37**	**0.000**
Drug Dependence	61% (54.2-67.9%)	4% (0.2-7.8%)	**106.42**	**0.000**
Sedatives Abuse	2.1% (0.1-4%)	0% (-)	**3.34**	**0.068**
Sedatives Dependence	0.5% (-)	0% (-)	0.83	0.362
Cannabis Abuse	18.5% (13-23.9)	1% (-)	**25.04**	**0.000**
Cannabis Dependence	55.9% (48.9-62.9%)	4% (0.2-7.8%)	**91.47**	**0.000**
Amphetamine Abuse	6.7% (3.2-10.2%)	1% (-)	**5.94**	**0.015**
Amphetamine Dependence	1.5% (-)	0% (-)	**2.5**	**0.114**
Opiates Abuse	0% (-)	0% (-)		
Opiates Dependence	1.5% (-)	0% (-)	**2.5**	**0.114**
Cocaine Abuse	0.5% (-)	1% (-)	0.22	0.639
Cocaine Dependence	2.1% (0.1-4%)	0% (-)	**3.34**	**0.068**
Hallucinogens Abuse	2.1% (0.1-4%)	0% (-)	**3.34**	**0.068**
Hallucinogens Dependence	0.5% (-)	0% (-)	0.83	0.362
Multiple drug use Abuse	8.2% (4.4-12.1%)	0% (-)	**13.71**	**0.000**
Multiple drug use Dependence	14.9% (9.9-19.9%)	0% (-)	**25.61**	**0.000**
Others Abuse	3.1% (0.7-5.5%)	0% (-)	**5.03**	**0.025**
Others Dependence	0.5% (-)	0% (-)	0.83	0.360
Anxiety Disorders	22.6% (16.7-28.4%)	24% (15.6-32.4%)	0.08	0.782
Panic disorder and/or Agoraphobia	3.1% (0.7-5.5%)	9% (3.4-14.6%)	**4.5**	**0.034**
Panic disorder with Agoraphobia	1.5% (-)	3% (-)	0.67	0.413
Panic disorder without Agoraphobia	0% (-)	2% (-)	**4.35**	**0.037**
Agoraphobia without Panic Disorder	1.5% (-)	4% (0.2-7.8%)	1.62	0.203
Social Phobia	4.1% (1.3-6.9%)	6% (1.3-10.7%)	0.51	0.476
Specific Phobia	11.3% 6.8-15.7%)	9% (3.4-14.6%)	0.37	0.541
Obsessive-Compulsive Disorder	1% (-)	3% (-)	1.44	0.230
Posttraumatic Stress Disorder	7.2% (3.6-10.8%)	6% (1.3-10.7%)	0.15	0.700
Generalised Anxiety Disorder	2.1% (0.1-4%)	1% (-)	0.48	0.489
Eating Disorders	4.6% (1.7-7.6%)	4% (0.2-7.8%)	0.06	0.806
Anorexia Nervosa	3.1% (0.7-5.5%)	2% (-)	0.31	0.580
Bulimia Nervosa	1.5% (-)	2% (-)	0.08	0.774
Mood Disorders	28.2% (21.9-34.5%)	21% (13-29%)	**1.84**	**0.175**
Major Depression	23.1% (17.2-29%)	19% (11.3-26.7%)	0.66	0.418
- Single Episode	13.3% (8.6-18.1%)	16% (8.8-23.2%)	0.38	0.538
- Recurrent Episodes	9.7% (5.6-13.9%)	3% (-)	**5.02**	**0.025**
Dysthymic Disorder	3.1% (0.7-5.5)	2% (-)	0.31	0.580
Bipolar Disorders	1.5% (-)	0% (-)	**2.5**	**0.114**
Hypomania	0.5% (-)	0% (-)	0.83	0.362
Somatoform Disorders	0.5% (-)	0% (-)	0.83	0.362
Somatisation Disorder	0% (-)	0% (-)		
Pain Disorder	0% (-)	0% (-)		
Hypochondria	0.5% (-)	0% (-)	0.83	0.362
Unspecific somatoform disorder	0% (-)	0% (-)		
Psychotic Disorders	0% (-)	0% (-)		
Adjustment Disorder	7.7% (4-11.4%)	5% (0.7-9.3%)	0.8	0.373
AD(H)S	8.7% (4.8-12.7%)	0% (-)	**14.6**	**0.000**
Borderline	1.5% (-)	0% (-)	**2.5**	**0.114**

Independent from the question of representativeness of the estimated prevalences, it is possible to compare the user and the control population for differences concerning the number of diagnoses measured within the study (Substance Use Disorders excluded). The users (MD=1) were diagnosed with marginally more mental disorders than the controls (MD=0) (Figure 86).

All mental disorders that were queried and the corresponding lifetime prevalences for users and controls of the present study are listed in Table 62. Clear differences between users and controls were found – by chi-square testing – for Alcohol, Cannabis, Multiple Drug and general Drug Abuse and Dependence. The users have higher prevalences in these categories. Moreover, significantly more users were diagnosed with having abused "other drugs" (i.e. sniffing agents, methylphenidate) as well as amphetamine. Additionally, marginally higher lifetime prevalences for the user population were found for the following Substance Use Disorders: Amphetamine Dependence, Sedatives Abuse, Opiates Dependence, Cocaine Dependence and Hallucinogens Abuse.

With respect to Anxiety Disorders, controls have or had slightly more Panic Disorders without Agoraphobia than users. For Mood Disorders, a marginally significant difference was found. While, in general, the prevalence of a Major Depression does not differ between users and controls, users have more Recurrent Episodes and marginally more Bipolar Disorders (i.e. Bipolar II Disorder, Cyclothymia). Furthermore, users stated to have more AD(H)D diagnoses and to have been slightly more often diagnosed with Borderline Personality Disorder.

14.15.2.2 Substance use Disorder within the study sample

When plotting the outcome of the SCID-I concerning current substance use by the consumption groups of the main substances used[64], a clear relation between consumption intensity and the current diagnosis becomes obvious (Figure 87). The more one consumes, the more likely Dependence and Abuse are diagnosed. The differences between the substances cannot be interpreted because the classification into *moderate*, *heavy* and *excessive consumption* is substance-specific (e.g. moderate cannabis use≤1 unit/day versus moderate use of hard drugs≤2 episodes/month)[65].

Withdrawal symptoms most often occurred in the case of cannabis dependence (Figure 88, left). The symptoms that were named most often were sleeplessness, restlessness and bad temper. Subjects who were diagnosed with alcohol

[64] For stimulants, an interview outcome with any fulfilled criteria for current Multiple Drug Use (Dependence, partial remission, abuse, full remission, no diagnosis) was also taken into account if one currently used substance was a stimulant (defined as amphetamine, ecstasy, cocaine) (N=14 out of 23).

[65] Alcohol: Moderate use (N=167): ≤24 g/day (male), ≤12 g/day (female);
Heavy use (N=100): >24-60 g/day (male), >12-40 g/day (female);
Excessive use (N=28): >60 g/day (male), >40 g/day (female).
Cannabis: Moderate use (N=105): >0-<1 unit/day; Heavy use (N=45):1-<2 units/day;
Excessive use (N=45): ≥2 units/day.
Stimulants: Moderate use (N=26): >0-≤2 episodes/month; Heavy use (N=20): ≤6 episodes/month;
Excessive use (N=19): >6 episodes/month.

dependence always stated to have developed an alcohol *tolerance* and to spend large amounts of time on drinking alcohol or recovering from its effects (*Time costs*). A lot of subjects that were dependent on cannabis or stimulants stated to have a persistent desire to cut down or control substance use but fail to do so (*Desire to change*). Only 15% of all alcohol dependent subjects made this confession. Concerning Substance Abuse, no distinct differences were found regarding the substance that was abused (Figure 88, right).

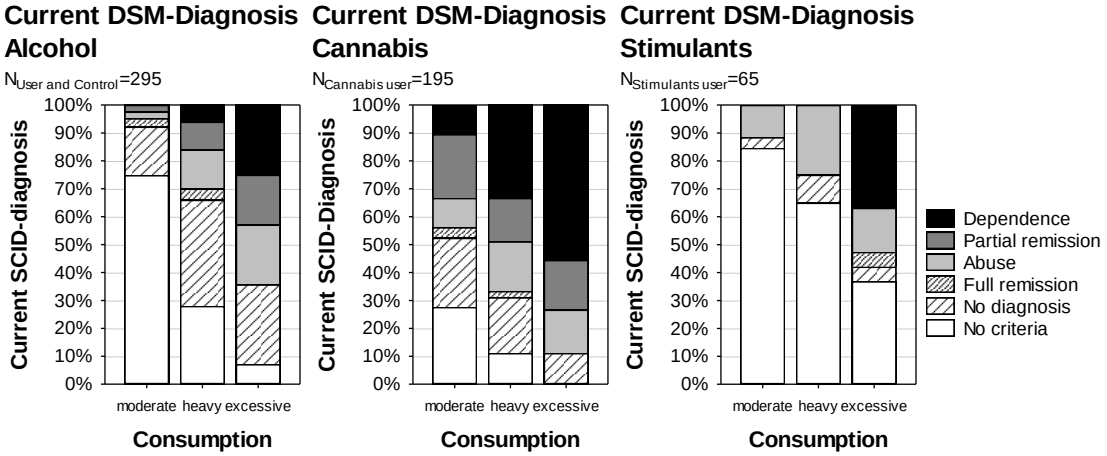


Figure 87: Percentage of current diagnoses of Abuse, Dependence (Dependence, Partial remission, Full remission) and not fully diagnosed Abuse/Dependence (No diagnosis) versus no fulfilment of any criteria (No criteria) for alcohol ($N_{User\ and\ Control}$=295), cannabis ($N_{Cannabis\ user}$=195) and stimulants ($N_{Stimulants\ user}$=65).

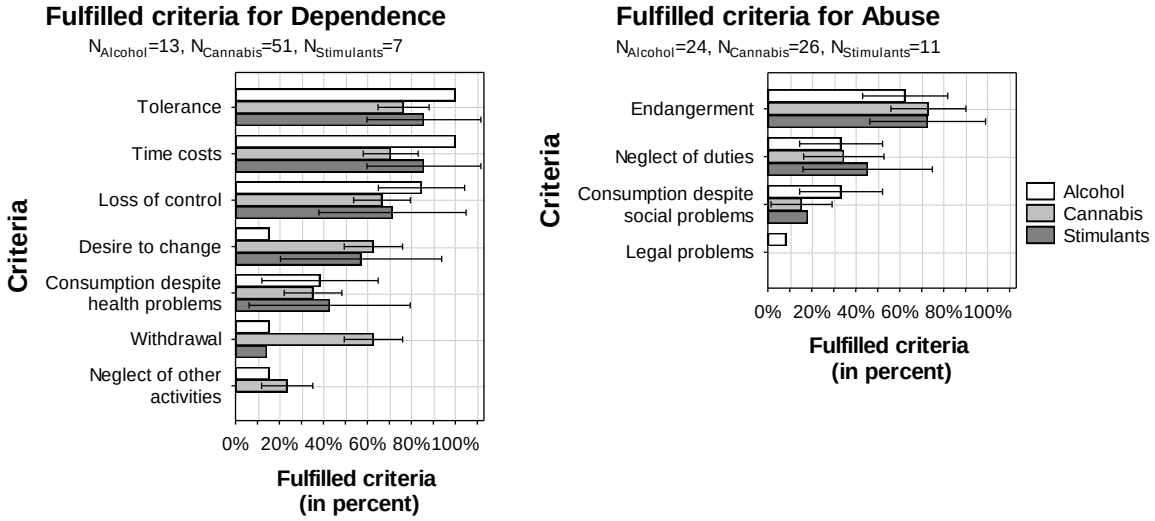


Figure 88: Fulfilment of criteria in the case of a Dependence ($N_{Alkohol}$=13, $N_{Cannabis}$=51, $N_{Stimulants}$=7; left) or Abuse ($N_{Alkohol}$=24, $N_{Cannabis}$=26, $N_{Stimulants}$=11, right) (in percent, ±0.95 CI).

All users were asked if they intend to reduce or stop drug consumption in the near or distant future. If so, they had to indicate to which drug the intention refers (*hard*

drugs[66], *alcohol*, *and/or cannabis*). Highly involved drug users are more willing to reduce/quit consumption than users whose consumption intensity is rather low (Figure 89). The effect is significant for *hard drugs*, *alcohol* and *cannabis* (Table 63). The difference between the drugs cannot be interpreted because the classifications of *moderate*, *heavy* and *excessive consumption* are substance-specific (e.g. moderate cannabis use≤1 unit/day versus moderate use of hard drugs≤2 episodes/month)[67].

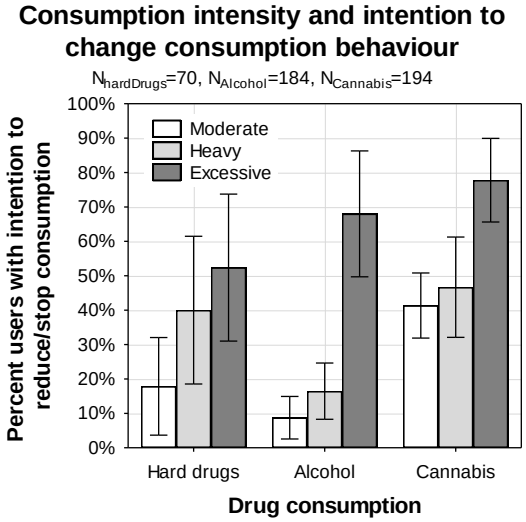


Figure 89: Consumption intensity and percentage of subjects who intended to reduce/stop consumption for moderate, heavy and excessive users of hard drugs, alcohol and cannabis ($N_{hardDrugs}$=70, $N_{Alcohol}$=184, $N_{Cannabis}$=194).

Table 63: Percentage (±0.95 CI) and statistics of users who intended to reduce/stop consumption ($N_{hardDrugs}$=70, $N_{Alcohol}$=184, $N_{Cannabis}$=194).

Intention to reduce/stop consumption					
	$Perc._{Mode.}$ (±0.95 CI)	**$Perc._{Heavy}$ (±0.95 CI)**	**$Perc._{Exce.}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
Hard drugs	17.9% (3.7-32%)	40% (18.5-61.5%)	52.38% (31-73.7%)	6.9 (2)	0.032
Alcohol	8.8% (2.6-14.9%)	16.5% (8.3-24.6%)	68% (49.7-86.3%)	42.77 (2)	0.000
Cannabis	41.3% (31.9-50.8%)	46.7% (32.1-61.2%)	77.8% (65.6-89.9%)	17.13 (2)	0.000

14.15.3 Personality

The literature was reviewed for psycho-social factors to predict drug driving (Chapter 5.2). Based on this literature review, it was decided to apply a series of eight personality questionnaires (Chapter 10.3; NEO-FFI - Personality, SSS - Sensation-Seeking, ADHDQ - Attention Deficit and Hyperactivity Disorder in childhood, SPSRQ

[66] Use of illegal drugs except cannabis and/or abuse of prescription medicines.
[67] Hard drugs: Moderate use (N=28): >0-≤2 episodes/month; Heavy use (N=20): ≤6 episodes/month; Excessive use (N=22): >6 episodes/month.
Alcohol: Moderate use (N=80): >0-≤24 g/day (male), >0-≤12 g/day (female); Heavy use (N=79): >24-60 g/day (male), >12-40 g/day (female); Excessive use (N=25): >60 g/day (male), >40 g/day (female).
Cannabis: see footnote 65 (Page 170).

- Sensitivity to Punishment and Sensitivity to Reward Questionnaire, UFB - Social Competence, IPC - Control beliefs, SVF - Stress-coping strategies, VIP - Traffic-specific item pool).

The following study groups were analysed for differences:

- Users versus controls and
- Users who committed many drives under influence (drives under the influence of illegal drugs and/or drives with a BAC above the legal limit) in 30 days versus users who committed no/some drives under influence (HighDUI versus LowDUI; categorisation by median-split)

The scores of each scale of the questionnaires were transformed into T-values according to the reference sample. If differences concerning age and gender are assumed, T-values for males/females and different age categories were available and used. For the questionnaire Attention Deficit and Hyperactivity Disorder in childhood (ADHDQ), given percentiles were used because T-values were not available (*<Perc25*, *Perc25-Perc50*, *>Perc50*). Multivariate Analyses of Variance were applied for each questionnaire. If the global result was significant or marginally significant, t-tests were applied afterwards (for ADHDQ: M-L Chi-square). To make a statement about the size of significant effects, effect sizes for t-tests ($\hat{\delta}$) and χ^2- tests (w), respectively, were calculated according to the following formula (Figure 90; Bortz & Döring, 2006):

$\hat{\delta} = t \cdot \sqrt{\frac{n_A + n_B}{n_A \cdot n_B}}$	n_A=Sample size of group A, n_B=Sample size of group B **Trivial effect**: <0.2 **Small effect**: 0.2-<0.5 **Medium effect**: 0.5-<0.8 **Strong effect**: ≥0.8
$w = \sqrt{\frac{\chi^2}{n}}$	n=Sample size **Trivial effect**: <0.1 **Small effect**: 0.1-<0.3 **Medium effect**: 0.3-<0.5 **Strong effect**: ≥0.5

Figure 90: Calculation and interpretation of effect sizes for t-test and χ^2-test, respectively (Bortz & Döring, 2006).

14.15.3.1 NEO-FFI

For the scales of the NEO-FFI (*Neuroticism*, *Extraversion*, *Openness to experience*, *Agreeableness* and *Conscientiousness*) no presumptions about the differences between the analysed subject groups were made. Compared to the controls, users scored lower on the scale *Conscientiousness* and higher on the scale *Openness to experience* (scales are described below the table) (Table 64; only significant results). Regarding the scale *Conscientiousness*, the effect can be described as medium, whereas the effect regarding the scale *Openness to experience* is small. No

difference was found for those users who drive a lot under influence and those who commit less DUI.

Table 64: NEO-FFI: Presumptions and significant test results.

Personality Questionnaire:					
NEO-FFI – Presumptions	no presumption				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Openness to experience	49.86	45.84	3.48	0.001	0.4
Conscientiousness	47.93	53	-3.94	0.000	0.5

Openness to experience

- Persons with a high score have a lively fantasy, have an accented sense of own feelings – of positive as well as negative feelings, are highly interested in personal as well as public matters; are eager for knowledge, are intellectual, imaginative, happy to try out new things, artistically minded; are willing to question existing norms and to respond to new social, ethical and political ideals; are independent in their judgments, behave unconventionally, try out new ways of thinking and acting, prefer variation
- Persons with a low score tend to behave conventional, tend to have conservative attitudes; prefer familiar things to new things, emotional reactions are rather subdued

Conscientiousness

- Persons with a high score describe themselves as focused, ambitious, hardworking, persistent, systematic, strong-minded, disciplined, reliable, punctual, tidy, accurate, fussy; have an exaggerated high level of aspiration, a compulsive tidiness, are workaholics
- Persons with a low score describe themselves as careless, phlegmatic and inconsistent; pursue goals with low commitment

14.15.3.2 Sensation Seeking (SSS)

For the Sensation Seeking Scales (SSS - *Thrill and Adventure Seeking*, *Disinhibition, Experience Seeking* and *Boredom Susceptibility*), it was presumed that users have higher scores on all scales compared to controls, especially those who commit many drives under influence. A strong effect was found for the scale *Experience Seeking*, a medium effect for the scale *Disinhibition* and a small effect for the Thrill *and Adventure Seeking* scale (Table 65). As presumed, users scored higher on these scales compared to controls. No difference was found for those users who drive a lot under influence and those who commit rather few drives under influence.

Table 65: SSS: Presumptions and significant test results.

Personality Questionnaire:					
SSS – Presumptions	User/HighDUI high on all scales				
Significant test results:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Thrill and adventure seeking	57.43	53.83	3.37	0.001	0.4
Disinhibition	59.66	53.59	5.62	0.000	0.7
Experience Seeking	57.98	49.43	7.9	0.000	1.0

Thrill and Adventure Seeking

- Persons with a high score tend to have diverse, new, complex and intense experiences, accept psychological, social and legal risks in return

Disinhibition

- Persons with a high score tend to behave socially and sexually disinhibited

Experience Seeking
- Persons with a high score try to gather new experiences through a non-conform lifestyle and travels

14.15.3.3 Sensitivity to Punishment and Sensitivity to Reward (SPSRQ)

For the SPSRQ (*Sensitivity to Punishment, Sensitivity to Reward*), it was presumed that, compared to controls, users would have lower scores on the scale *Sensitivity to Punishment* and higher ones on the scale *Sensitivity to Reward* and, again, especially those who commit many drives under influence. A medium effect was found for the scale *Sensitivity to Reward*. Users have higher scores than controls (Table 66). For the difference between the *Sensitivity to Reward* scale and the *Sensitivity to Punishment* scale, a small effect was found. Both effects are consistent with the presumptions. No difference was found for those users who drive a lot under influence and those who commit rather few drives under influence.

Table 66: SPSRQ: Presumptions and significant test results.

Personality Questionnaire:					
SPSRQ – Presumptions	User/HighDUI high on S. t. Reward and low on S. t. Punishment				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Sensitivity to Reward	53.11	48.64	3.76	0.000	0.5
S. t. Reward – S. t. Punishment	11.3	6.48	3.12	0.002	0.4

Sensitivity to Punishment
- Persons with a high score are motivated in response to cues for punishment and cues to frustrated non-reward

Sensitivity to Reward
- Persons with a high score are motivated in response to cues for reward and cues for omission of punishment

14.15.3.4 Social Competence (UFB)

For the scales conserning social competence (UFB - *Fear of blame and criticism*, *Fear of contact to those of the opposite sex/fear of responsibility*, *Inability to set plans and set plans into motion*, *Inability to say no*, *Feeling of self-blame in relation to one's own actions as they relate to and affect others*, *Inappropriately exaggerated feelings of embarrassment*), it was presumed that users would have higher scores on all scales compared to controls, especially those who commit many drives under influence. According to Kaplan (1975), adolescents with low self-esteem and low social competence are motivated to take action to restore positive self-regard by unlawful behaviour. A small effect was found for the scale *Inappropriately exaggerated feelings of embarrassment* (Table 67). Contrary to the original expectations, users scored lower on the scale compared to the controls. The result suggests that drug users are less embarrassed when they infringe social norms. This finding fits the one that was mentioned in Chapter 14.15.3.1 and indicated that users compared to controls are in general less conscientious. No difference was found for those users who drive a lot under influence and those who commit rather few drives under influence.

Table 67: UFB: Presumptions and significant test results.

Personality Questionnaire:					
UFB – Presumptions	User/HighDUI higher on all scales				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Inappropriately exaggerated feelings of embarrassment	48.26	51.05	-2.51	0.013	0.3

Inappropriately exaggerated feelings of embarrassment

- Persons with a high score are over-polite in reference to following norms and over-embarrassed when infringing on rules; show modest gestures, modest facial expressions and a modest involvement in conversation in social disturbing situations; prefer impersonal and controllable situations

14.15.3.5 Coping strategies (SVF)

For the SVF (*Compare with others*, *Guilt defence*, *Distraction from situation*, *Substitutional satisfaction*, *Situational control*, *Reaction control*, *Positive self-instruction*, *Need for social support*, *Avoidance*, *Flight tendency*, *Rumination*, *Resignation*, *Self-accusation*, *Self-medication/alcohol use;* Positive coping strategies: scale 1-7, Negative coping strategies: scale 10-13), it was presumed that users compared to controls would have higher scores on scales that describe negative coping strategies and lower scores on scales that describe positive coping strategies, especially those who commit many drives under influence. A strong effect was found for the scale *Self-medication/alcohol use* and a small effect for the sum score "Positive coping strategies" (Table 68). As presumed, users compared to controls scored higher on the negative scale *Self-medication/alcohol use* and those who committed no or a low number of drives under influence compared to those who had a lot of drives under influence scored higher on positive scales.

Table 68: SVF: Presumptions and significant test results.

Personality Questionnaire:					
SVF – Presumptions	User/HighDUI low on positive scales and high on negative scales				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Self-medication/alcohol use	56.59	48.36	7.50	0.000	0.9
Significant test result:	**$Mean_{HighDUI}$**	**$Mean_{LowDUI}$**	**t**	**p-value**	**ES**
Positive coping strategies	50.96	52.57	-2.13	0.035	0.3

Drug intake as coping strategy

- Persons with a high score tend to take drugs when they are under stress

Positive coping strategies

- Persons with a high score have more positive coping strategies (*Compare with others*, *Guilt defence*, *Distraction from situation*, *Substitutional satisfaction*, *Situational control*, *Reaction control*, *Positive self-instruction*)

14.15.3.6 Traffic-specific item pool (VIP)

For the scales of the VIP (*Orientation at social expectations*, *Uncritical self-perception*, *Aggressive interaction*, *Emotional relationship to car and driving*) no presumptions about the differences between the analysed subject groups were made. Compared to the controls, users scored lower on the scale *Uncritical self-*

perception (small effect) (Table 69). No difference was found for those users who drive a lot under influence and those who commit rather few drives under influence.

Table 69: VIP: Presumptions and significant test results.

Personality Questionnaire:					
VIP – Presumptions	no presumption				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Uncritical self-perception	38.83	45.86	-2.22	0.027	0.3

Uncritical self-perception of own driving behaviour

- Persons with a high score describe driving as uncritical even if critical driving situations or road conditions occur (e.g. driving in a rush, fog, unknown road, long drive)
- Persons with a low score admit that own driving behaviour is critical sometimes and in some situations

14.15.3.7 Control beliefs (IPC)

For the scales of the IPC (*Internal control orientation*, *Powerful others control orientation, Chance control orientation*), it was presumed that users would have less internal control (scale 1) and higher external control (scale 2-3) than controls. Compared to controls, users scored lower on the scale *Internal control orientation* (small effect) and higher on the scale *Chance control orientation* (medium effect) (Table 70). Those users who drive a lot under influence also scored higher on the scale *Chance control orientation* than those who commit rather few drives under influence (small effect).

Table 70: IPC: Presumptions and significant test results.

Personality Questionnaire:					
IPC – Presumptions	User/HighDUI low on internal control and high on external control				
Significant test result:	**$Mean_{User}$**	**$Mean_{Control}$**	**t**	**p-value**	**ES**
Internal control orientation	51.98	55.31	-2.82	0.005	0.4
Chance control orientation	53.74	48.72	4.14	0.000	0.5
Significant test result:	**$Mean_{HighDUI}$**	**$Mean_{LowDUI}$**	**t**	**p-value**	**ES**
Chance control orientation	55.49	52.05	2.39	0.018	0.4

Internal control orientation

- Persons with a high score are self-controlled/self-paced in reference to personal events and their own life
- Persons with a low score have a low level of autonomy

Chance control orientation

- Persons with a high score have an external control belief in terms of being resigned to one's fate, belief that life is unstructured and that it depends to a high degree on fate, coincidences and (mis)fortune

14.15.3.8 AD(H)D in childhood (ADHDQ)

For the scales of the ADHDQ (*Distractibility*, *Inattention*, *Hyperactivity/Impulsivity*, *Psycho-social consequences*, *Drug effect on inattention and hyperactivity*), it was presumed that users compared to controls would have higher scores on all scales, especially those who commit many drives under influence. Compared to controls, users scored higher on the scales 3-5 (Table 71). The effect concerning the scale

Psycho-social consequences was small, whereas the other two effects were medium. Those users who commit a lot of DUI scored higher on the same scores compared to users who had no/a few drives under influence. The effect concerning the scale *Drug effect on inattention and hyperactivity* was medium, whereas the other two effects were small.

Table 71: ADHDQ: Presumptions and significant test results.

Personality Questionnaire:					
ADHDQ – Presumptions	User/HighDUI higher on all scales				
Significant test result:	**analysis over all three percentiles:** **>Perc50$_{User}$**	**>Perc50$_{Control}$**	**chi-square (df)**	**p-value**	**ES**
Hyperactivity/Impulsivity	42%	22.7%	22.52 (2)	0.000	0.3
Psycho-social consequences	44.1%	24.7%	11 (2)	0.004	0.2
Drug effect on inattention and hyperactivity	62.9%	27.4%	51.18 (2)	0.000	0.4
Significant test result:	**>Perc50$_{HighDUI}$**	**>Perc50$_{LowDUI}$**	**chi-square (df)**	**p-value**	**ES**
Hyperactivity/Impulsivity	42.5%	32.5%	15.94 (2)	0.000	0.2
Psycho-social consequences	54.3%	29.3%	16.53 (2)	0.000	0.2
Drug effect on inattention and hyperactivity	70.7%	41.3%	29.02 (2)	0.000	0.3

Hyperactivity/Impulsivity
- Persons with a high score were hyperactive and impulsive in their childhood

Psycho-social consequences
- Persons with a high score had psychological problems and problems in social situations in their childhood because of being inattentive, hyperactive and impulsive

Drug effect on inattention and hyperactivity
- Persons with a high score describe a positive effect of psychoactive substance consumption on concentration, emotions, self-control, memory and perception

14.15.4 Social context

14.15.4.1 Peer influence and nights out

To be able to analyse the influence of peers, the subjects were asked how often they go out on average, if their partner or their friends use drugs, if their friends drive under influence and how their friends think about the subject's intoxicated driving. The questions are listed in Table 72.

Table 72: Q-Start questions concerning peer influence.

Question
How often do you go out on average (e.g. meet friends, party, disco, bar)? 5-7 times per week, 3-4 times per week, 1-2 times per week, 1-3 times per month, less frequently → **Nights out**
If you have a permanent partner, does he or she take drugs? yes, so-called „soft" drugs (cannabis); yes, so-called „hard" drugs (e.g. amphetamines, opiates, cocaine); yes, so-called „soft" and „hard" drugs; no, my partner does not take drugs; I have no permanent partner → **Partner's drug use**

Question
Assume that you are driving after the intake of the following substances, how would your friends react if they found out? (1 beer, more than 4 beers, cannabis, stimulants (e.g. amph.,speed), ecstasy, hallucinogens (e.g. LSD, mushrooms), cocaine, opiates (heroin and others), sedatives) 0=it wouldn't bother them …10=they would disapprove of it **→ Peers' opinion about subject's impaired driving**
How many of your friends with whom you have regular contact take so-called „soft" drugs (cannabis)? no one, few, about the half, many **→ Peers' drug use (soft drugs)**
How many of your friends with whom you have regular contact take so-called „hard" drugs (amphetamines, opiates, cocaine)? no one, few, about the half, many **→ Peers' drug use (hard drugs)**
How many of your friends with whom you have regular contact take illegal drugs and drive afterwards? no one, few, about the half, many **→ Peers' drug driving**

Users have more nights out than controls (t=3.63, p=0.000), as do younger subjects compared to older subjects (18-24 vs. 25-29: t=2.12; p=0.035, 18-24 vs. 30-39: t=5.18; p=0.000, 25-29 vs. 30-39: t=2.86; p=0.005) (Figure 91).

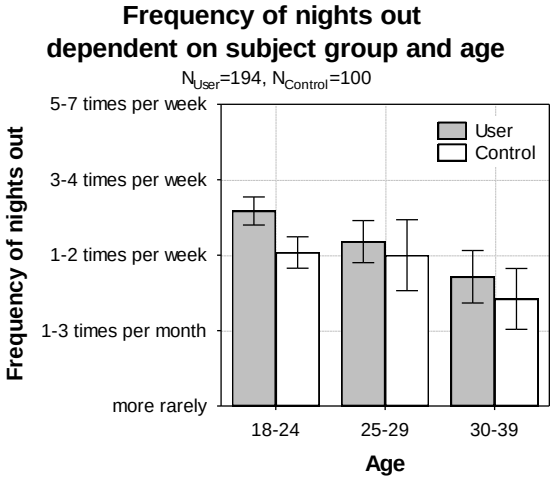


Figure 91: Frequency of nights out (5-7 times per week, 3-4 times per week, 1-2 times per week, 1-3 times per month, more rarely), depending on subject group (user, control) and age (18-24, 25-29, 30-39) (N_{User}=194; $N_{Control}$=100; Mean, ±0.95 CI).

The more often someone goes out, the higher the consumed alcohol dose per day is (Figure 92). The use of cannabis and stimulants does not vary depending on the frequency of nights out.

The more often someone goes out, the more drives under the influence of alcohol one has (BAC≥0.01%) (Figure 93, left). Driving under the influence of stimulants does not vary depending on the frequency of nights out. For cannabis, it can be shown that those who go out quite often (*5-7 times per week*) and those who go out rather seldom (*1-3 times per months*) especially have high numbers of THC-positive drives (THC≥1ng/ml) (Figure 93, right).

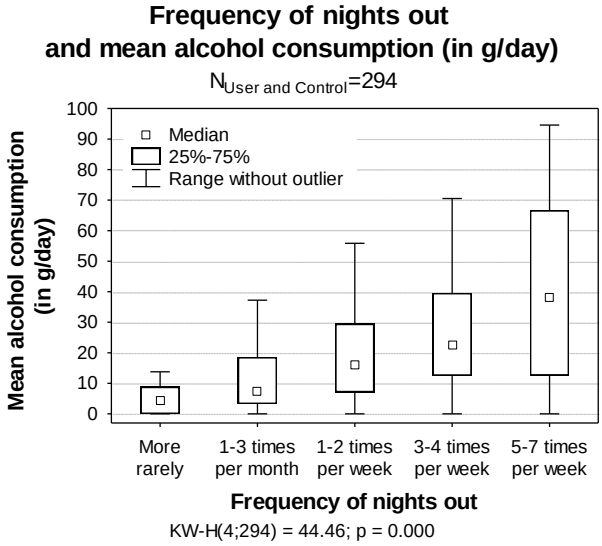


Figure 92: Frequency of nights out (5-7 times per week, 3-4 times per week, 1-2 times per week, 1-3 times per month, more rarely) and mean alcohol consumption (in g/day) for users and controls ($N_{User\ and\ Control}$=294; Median, 25%-75%, range without outlier).

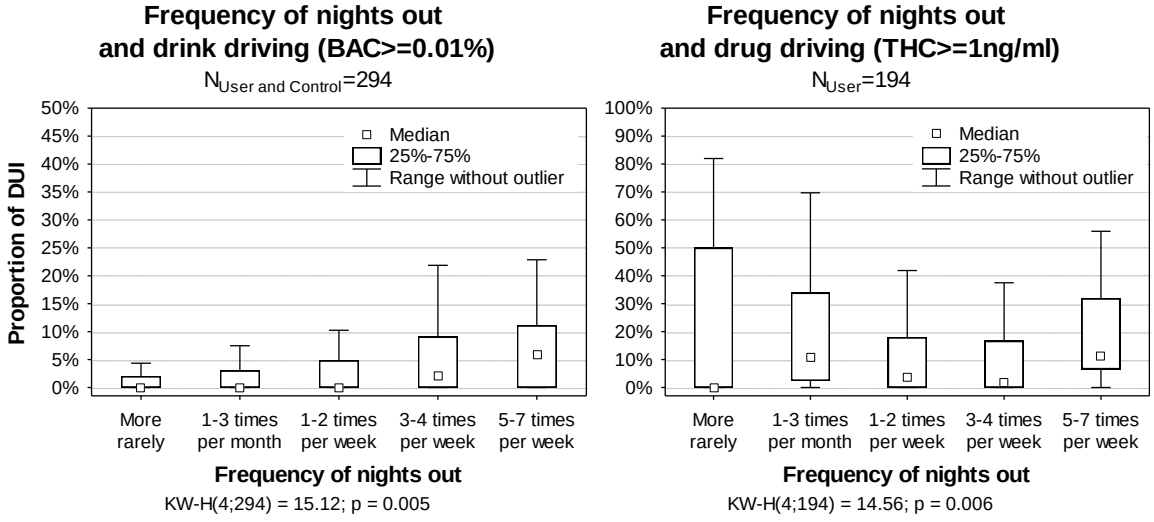


Figure 93: Frequency of nights out (5-7 times per week, 3-4 times per week, 1-2 times per week, 1-3 times per month, more rarely) and mean proportion of driving under the influence of alcohol (BAC≥0.01%; left) for users and controls ($N_{User\ and\ Control}$=294) and of driving under the influence of cannabis (THC≥1ng/ml; right) for users (N_{User}=194) (Median, 25%-75%, Range without outlier).

51.6% of the users declared having a permanent relationship (±0.95 CI: 44.5%-58.3%) compared to 54% of the controls (±0.95 CI: 44.2%-63.8%). Those users who are not in a relationship and those who have a relationship with a partner who uses hard drugs consume more drugs a day and more often "hard" drugs[68] (*yes, so-called „hard" drugs*, *yes, so-called „soft" and „hard" drugs*) than those who have a partner who does not consume drugs or who consumes only soft drugs (Figure 94). It was

[68] "hard" drugs: illegal drugs, except cannabis, and/or abused prescription medicines.

also found that if a female user stated to have a partnership, it was much more likely that the partner also used drugs (89.6%, ±0.95 CI: 80.9%-89.2%) compared to partners of male drug users (54.4%, ±0.95 CI: 42.6%-66.2%).

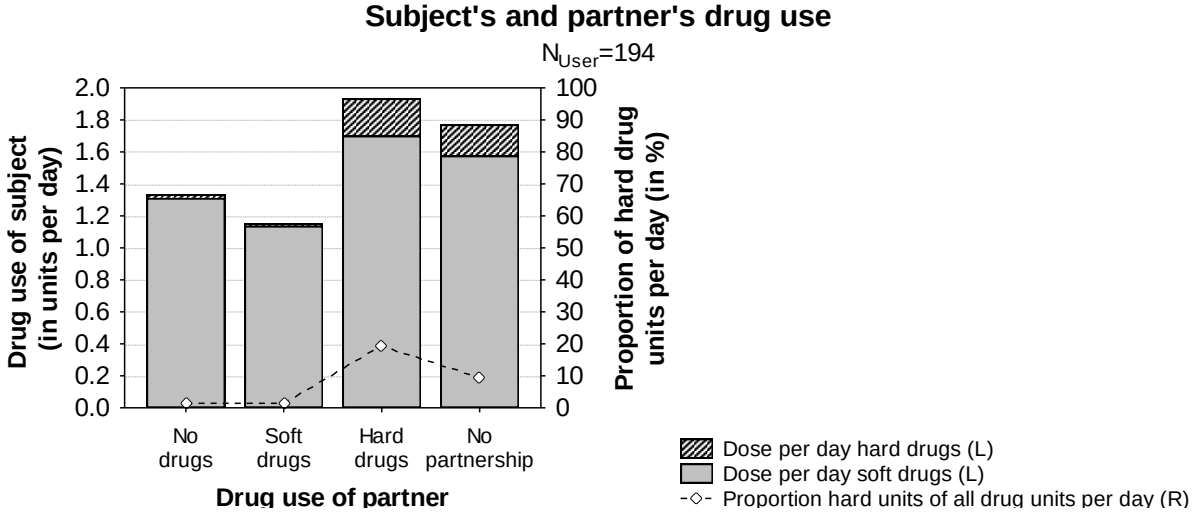


Figure 94: Mean "soft" and "hard" drug use of users (N_{User}=194) in units per day (e.g. joints in the case of cannabis) and mean proportion of "hard" drug units per day, depending on drug use of partner (no drugs, "soft" drugs, "hard" drugs, no partnership).

76.4% of the users declared being part of a clique (±0.95 CI: 70.4%-82.5%) compared to 65% of the controls (±0.95 CI: 55.7%-74.3%). Users who had no drives with a BAC of 0.05% or higher/a median proportion of cannabis-positive drives or less declared that their friends would more often disapprove of them driving after they drank more than four beers/driving after consuming cannabis compared to users who had drives with a BAC of 0.05% or higher/a higher proportion of cannabis-positive drives than the median (Figure 95, Table 73).

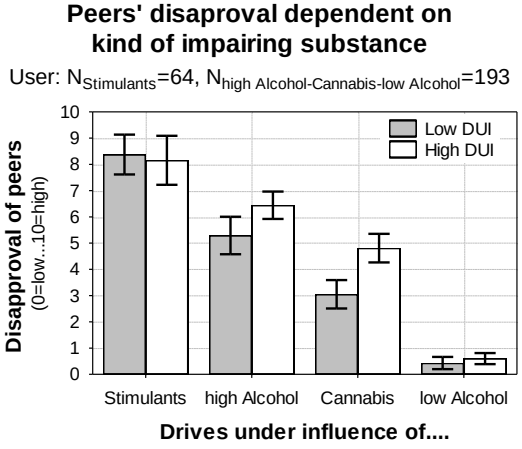


Figure 95: Peers' disapproval (scale: 0=low…10=high), depending on kind of DUI (stimulants, high alcohol, cannabis, low alcohol) for subjects who either had no/a median proportion of DUI or less (Low DUI) or those who had drives under influence/a higher proportion than the median (High DUI) ($N_{Stimulants}$=64; $N_{high\ Alcohol\text{-}Cannabis\text{-}low\ Alcohol}$=193; Mean, ±0.95 CI).

Concerning drives after the consumption of stimulants or one beer, no difference was observable between those who had a higher proportion than the median proportion of corresponding drives and those who had a lower proportion. Peers highly disapprove of drives under the influence of stimulants and hardly ever disapprove of drives after the consumption of one beer.

Table 73: Mean rating (±0.95 CI) and statistics of peers' disapproval.

Peers' disapproval				
DUI-Substance	**Mean$_{highDUI}$ (±0.95 CI)**	**Mean$_{lowDUI}$ (±0.95 CI)**	**t**	**p-value**
Stimulants	8.4 (7.6-9.1)	8.2 (7.2-9.1)	-0.37	0.712
high Alcohol	5.3 (4.6-6)	6.4 (5.9-7)	2.61	0.010
Cannabis	3.1 (2.5-3.6)	4.8 (4.3-5.4)	4.55	0.000
low Alcohol	0.4 (0.2-0.7)	0.6 (0.4-0.8)	1.08	0.281

The more the peers use drugs in the subject's point of view, the higher the subject's daily drug dose is (significant for "hard" drugs and marginally significant for "soft" drugs) (Figure 96). The more the peers drive under influence in the subject's point of view, the higher the subject's proportion of drives under influence is.

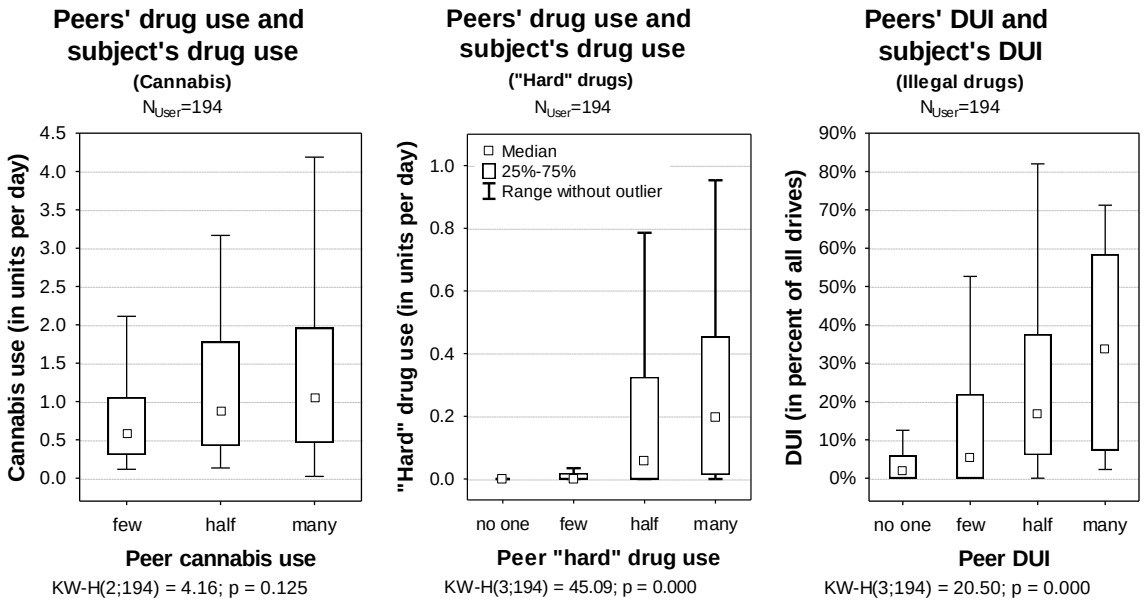


Figure 96: Cannabis use (left, in units per day), use of "hard" drugs (middle, in units per day) and drives under the influence of illegal drugs (right, in percent) of subjects (N_{User}=194) and of peers (no one, few, half, many) (Median, 25%-75%, Range without outlier).

14.15.4.2 Parents' influence

To analyse the parental influence on the subject's drug use and drug driving behaviour, the subjects were asked about their relationship with their parents, if they favour the way they were raised and if they would raise their children in the same manner. They were asked about their father's educational status and his job position and if the parents lived together or apart. The questions are listed in Table 74 and Table 75.

Table 74: Q-Start questions concerning parents' influence and parental home.

Question
Would you bring up your child like your parents brought you up or would you do it different? in the same manner, similarly, differently, completely differently → **Own way of raising child**
How did your parents bring you up? very strict, strict, lenient, too lenient → **Parents' way of raising child**
What is your father's highest graduation? No/basic education, middle education, advanced education → **Father's educational status**
What is your father's job position? Working family member/househusband, worker, simple work, clerical work, upper work, higher work, freelance academic, self-employed → **Job position of father**
Did your parents live together, did they live apart or were they divorced? Live(d) together, live(d) apart, are (were) divorced → **Parents' marital status**
How much beer, wine or liquor does your father/mother drink on a usual Saturday evening? → **Parents' alcohol consumption**

Table 75: Questions about the relationship with parents according to the German study "Jugend 2000" (Deutsche Shell, 2000).

Relationship with parents (Response option: 1=not at all true, 2=little true, 3=true, 4=very true)	
Abbr.	**Scale and Items**
Resp	**Respectful connection with parents**
R_1	I always had a lot of respect for my parents.
R_2	The family bond within our family is much stronger than within other families.
R_3	In my life, my parents always came first.
R_4	My parents are my role models.
Trus	**Mistrust in child**
T_1	My parents always reproached me for making mistakes.
T_2	My parents always mistrusted me.
T_3	My parents are extremely old-fashioned.
T_4	My parents always criticised me.
Mate	**Generous fulfilment of child's material wishes**
M_1	I always got everything from my parents that I wanted.
M_2	When I asked for a toy, I always got it.
M_3	In my family, we always had enough money to fulfil our material wishes.
M_4	In my family, we always had to save money and carefully had to think about what we spent it on. (R)
Worr	**Parents' worries**
W_1	My parents were always worried about me.
W_2	My parents were always concerned about me using cannabis.
W_3	My parents were always concerned about me keeping bad company.
W_4	My parents were always concerned about my future.
Perf	**Parents' performance claims**
P_1	My parents always asked about my school matters.
P_2	In my family, school grades were very important.
P_3	My parents always encouraged me to be punctual and tidy.
P_4	My parents always had high hopes for me.

Relationship with parents (Response option: 1=not at all true, 2=little true, 3=true, 4=very true)	
Abbr.	**Scale and Items**
Self	**Child's self-reliance**
S_1	My parents never influenced me in important decisions.
S_2	My parents were always very proud of me.
S_3	In my opinion, my parents were always satisfied with me.
S_4	My parents always let me do what I thought was right.
Symp	**Parents' sympathy**
Sy_1	I always felt that my parents understood me best.
Sy_2	My parents always helped me with my homework.
Sy_3	My parents always tried to understand me.
Sy_4	My parents tried to understand me to the extent that they even shared my interests and hobbies.

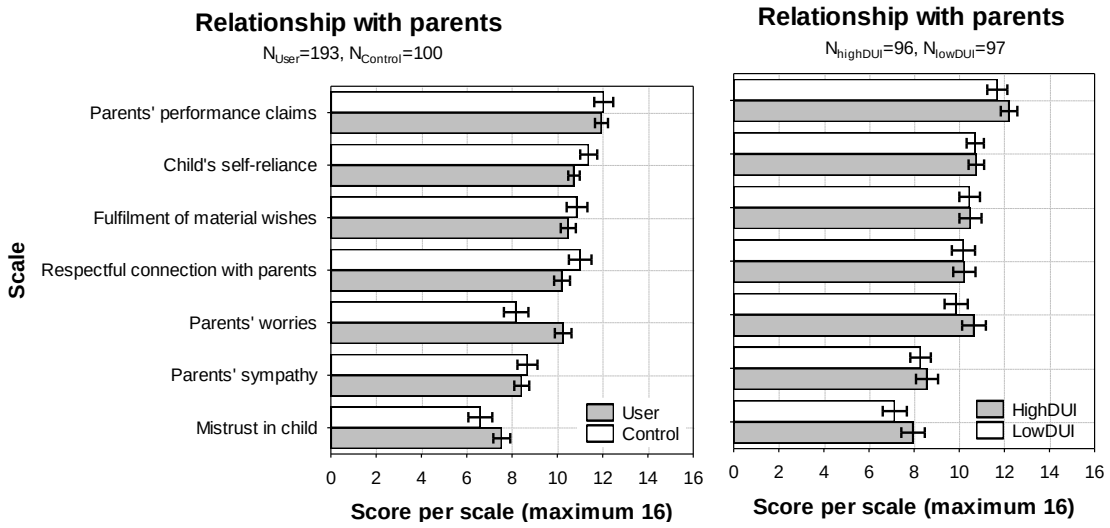


Figure 97: Scores that describe relationship with parents (respectful connection with parents, mistrust in child, generous fulfilment of child's material wishes, parents' worries, parents' performance claims, child's self-reliance, parents' sympathy) for users versus controls (left, N_{User}=193, $N_{Control}$=100) and frequent versus infrequent drug drivers (right, $N_{highDUI}$=96, N_{lowDUI}=97)(Mean, ±0.95 CI).

Table 76: Mean rating (±0.95 CI) and statistics of relationship with parents (significant and marginal significant results) for users and controls (N_{User}=193, $N_{Control}$=100) and frequent and infrequent drug drivers ($N_{highDUI}$=96, N_{lowDUI}=97).

Relationship with parents				
Scale	**Mean$_{User}$ (±0.95 CI)**	**Mean$_{Control}$ (±0.95 CI)**	**F**	**p-value**
Child's self-reliance	10.7 (10.5-11)	11.4 (11-11.8)	-8.35	0.004
Respectful connection with parents	10.2 (9.9-10.6)	11 (10.5-11.5)	-6.79	0.010
Parents' worries	10.3 (9.9-10.6)	8.2 (7.6-8.7)	40.90	0.000
Mistrust in child	7.5 (7.2-7.9)	6.6 (6.1-7.1)	8.47	0.004
Scale	**Mean$_{highDUI}$ (±0.95 CI)**	**Mean$_{lowDUI}$ (±0.95 CI)**	**F**	**p-value**
Parents' performance claims	12.2 (11.8-12.6)	11.7 (11.2-12.1)	3.22	0.074
Parents' worries	10.7 (10.1-11.2)	9.9 (9.4-10.4)	4.56	0.034
Mistrust in child	8 (7.4-8.5)	7.1 (6.6-7.7)	4.65	0.032

Users scored higher than controls on the scales *Parents' worries* and *Mistrust in child* (Figure 97, left, Table 76). Controls scored higher than users on the scales *Child's self-reliance* and *Respectful connection with parents*. So, the controls' relationship to

their parents can be described as better as that of the users'. Comparing those users who often drive under influence (*highDUI*) with those who commit rather less drives under influence (*lowDUI*) results in differences concerning *Parents' worries*, *Mistrust in child* and a marginal difference concerning *Parents' performance claims* (Figure 97, right, Table 76). The ones who drive under influence more often reach higher scores compared to those who drive less often under influence. Nevertheless, one should consider that the differences between the study groups are in the majority of the cases smaller than one point out of 16 points on the scale.

70.3% of the users stated that the parents' way of raising them was *too lenient/lenient* compared to 59% of the controls (Figure 98, left). This difference reached significance (Table 77). 41.5% of the users compared to 33% of the controls stated that they would raise their own children *completely differently/differently* than their parents raised them (not significant; Figure 98, right). Between frequent drug drivers (*highDUI)* and rather infrequent drug drivers (*lowDUI),* no clear differences were found concerning the parents' way and their own way of raising children (Table 77, not diagrammed below). The former marginally more often stated that the parents' way of raising them was *too lenient/lenient*.

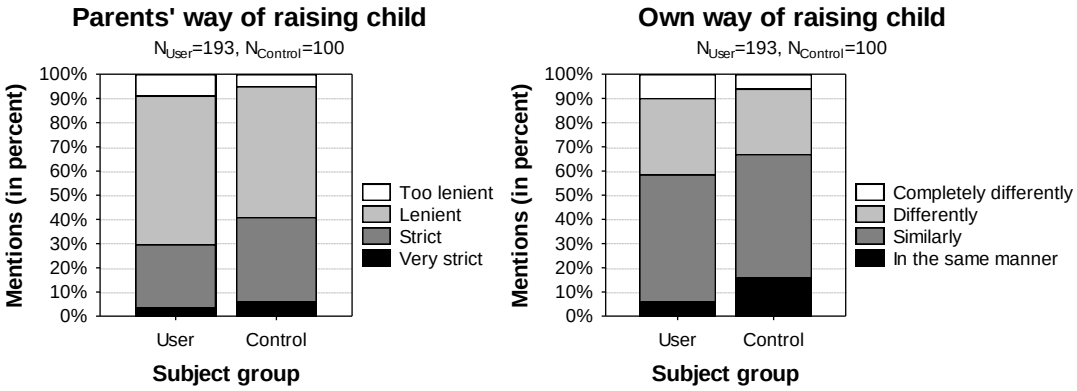


Figure 98: Parents' way of raising child (too lenient, lenient, strict, very strict) and own way of raising child (completely differently, differently, similarly, in the same manner) for users (N_{User}=193) and controls ($N_{Control}$=100) (in percent of mentions).

Table 77: Percentage (±0.95 CI) and statistics of describing the parents' way of raising child as too lenient/lenient and the intended own way of raising child as completely differently/differently for users and controls (N_{User}=193, $N_{Control}$=100) and frequent and infrequent drug drivers ($N_{highDUI}$=96, N_{lowDUI}=97).

Parents' way of raising child too lenient/lenient versus strict/very strict			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
70.3 (63.9%-76.8%)	59% (49.4%-68.6%)	3.77 (1)	0.052
$Percent_{HighDUI}$ (±0.95 CI)	**$Percent_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
68.4% (59.1%-77.8%)	39.2% (29.5%-48.9%	1.99 (1)	0.159
Own way of raising child completely differently/differently versus similarly/in the same manner			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
41.5% (34.5%-48.4%)	33% (23.8%-42.2%)	0.32 (1)	0.570
$Percent_{HighDUI}$ (±0.95 CI)	**$Percent_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
43.8% (33.8%-53.7%)	39.2% (29.5%-48.9%)	0.42 (1)	0.519

52.4% of the users stated that their father has an *advanced* educational status compared to 42.9% of the controls (Figure 99). This difference almost reached significance (Table 78). Between frequent drug drivers (*highDUI)* and rather infrequent drug drivers (*lowDUI),* the father's educational status did not differ significantly (Table 78, not diagrammed below).

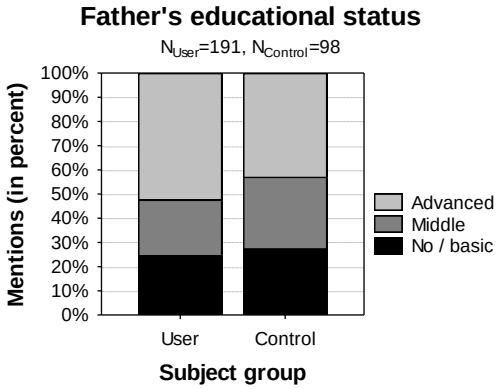


Figure 99: Father's educational status (advanced, middle, no/basic) for users (N_{User}=191) and controls ($N_{Control}$=98) (in percent of mentions).

Table 78: Percentage (±0.95 CI) and statistics of mentioning the father's educational status to be advanced for users and controls (N_{User}=191, $N_{Control}$=98) and frequent and infrequent drug drivers ($N_{highDUI}$=96, N_{lowDUI}=97).

Advanced educational status of father versus middle/no/basic			
Percent$_{User}$ (±0.95 CI)	**Percent$_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
52.4% (45.3%-59.4%)	42.9% (33.1%-52.7%)	2.34 (1)	0.126
Percent$_{HighDUI}$ (±0.95 CI)	**Percent$_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
48.9% (38.8%-59%)	55.7% (45.8%-65.6%)	0.87 (1)	0.352

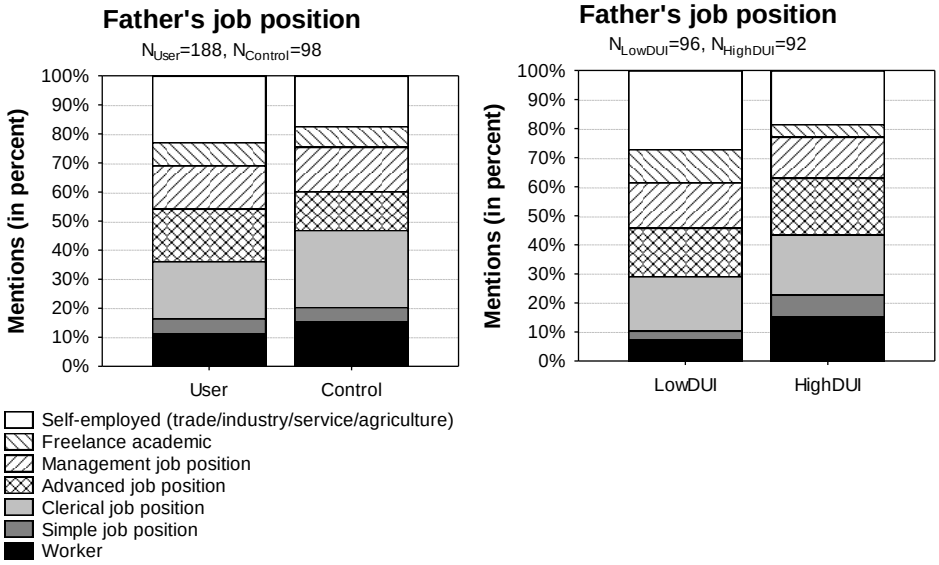


Figure 100: Father's job position (self-employed, freelance academic, management/advanced/clerical/simple job position, worker) for users versus controls (left, N_{User}=188, $N_{Control}$=98) and frequent versus infrequent drug drivers (right, $N_{HighDUI}$=92, N_{LowDUI}=96) (in percent of mentions).

63.8% of the users compared to 53.1% of the controls stated that their father has a *management* or *advanced job position*, is a *freelance academic* or *self-employed* (Figure 100, right). This difference almost reached significance (Table 79). The frequent drug drivers (*highDUI*) indicated in 56.5% of the cases compared to 70.8% of the rather infrequent drug drivers (*lowDUI*) that the father has a higher job position (Figure 100, left). This difference reached significance (Table 79).

Table 79: Percentage (±0.95 CI) and statistics of mentioning the father's job position to be high (self-employed, freelance academic, management/advanced job position) for users versus controls (N_{User}=188, $N_{Control}$=98) and frequent versus infrequent drug drivers ($N_{HighDUI}$=92, N_{LowDUI}=96).

High job position of father versus low			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
63.8% (57%-70.7%)	53.1% (43.2%-62.9%)	3.12 (1)	0.078
$Percent_{HighDUI}$ (±0.95 CI)	**$Percent_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
56.5% (46.4%-66.7%)	70.8% (61.7%-79.9%)	4.17 (1)	0.041

36.5% of the users compared to 26.3% of the controls stated that their parents *live(d) apart* or *are/were divorced* (Figure 101). This difference almost reached significance (Table 80). Between frequent drug drivers (*highDUI)* and rather infrequent drug drivers (*lowDUI),* the marital status of the parents did not differ significantly (Table 80, not diagrammed below).

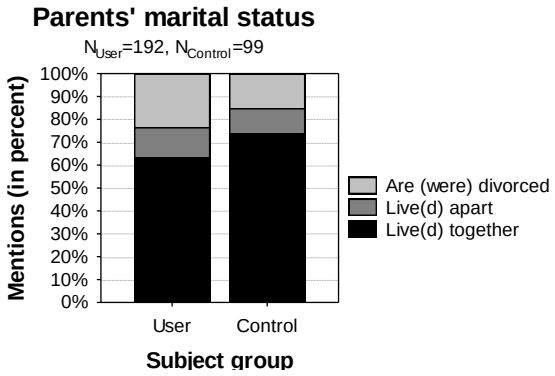


Figure 101: Parents' marital status (are (were) divorced, live(d) apart, live(d) together) for users (N_{User}=192) and controls ($N_{Control}$=99) (in percent of mentions).

Table 80: Percentage (±0.95 CI) and statistics of mentioning that parents are not living together for users versus controls (N_{User}=192, $N_{Control}$=99) and frequent versus infrequent drug drivers ($N_{HighDUI}$=95, N_{LowDUI}=97).

Parents live/lived apart, are/were divorced versus live(d) together			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
36.5% (29.7%-43.3%)	26.3% (17.6%-34.9%)	3.07 (1)	0.080
$Percent_{HighDUI}$ (±0.95 CI)	**$Percent_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
33.7% (24.2%-43.2%)	39.2% (29.5%-48.9%)	0.62 (1)	0.429

The subjects whose alcohol consumption was high or excessive stated a higher alcohol consumption of their parents (father: MD 40 grams, ±0.95 CI 0-60 grams; mother: MD 20 grams, ±0.95 CI 0-40 grams) than moderate alcohol users (father: MD 6.4 grams, ±0.95 CI 0-40 grams; mother: MD 0 grams, ±0.95 CI 0-24 grams) (Figure 102).

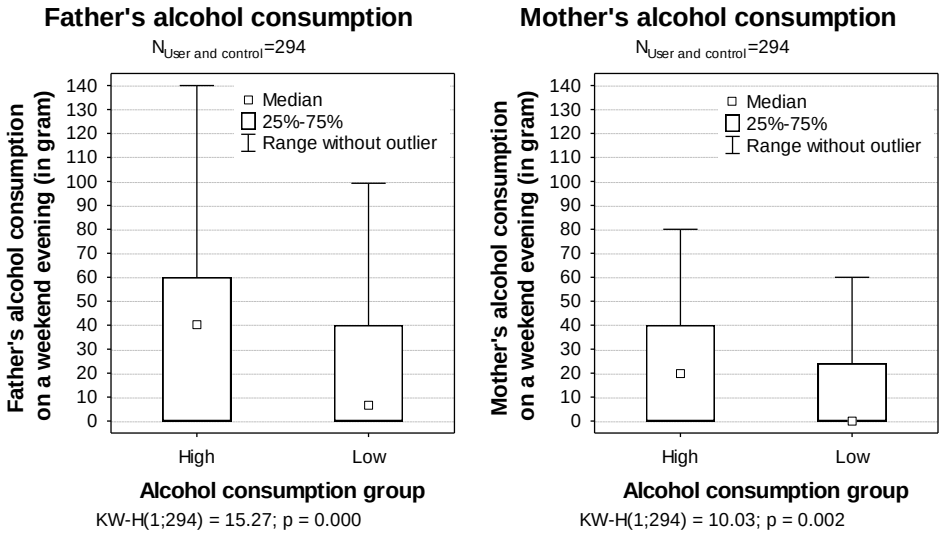


Figure 102: Father's (left) and mother's (right) alcohol consumption on a regular weekend evening (in grams) for heavy/excessive (High alcohol consumption group) versus moderate/no alcohol users (Low alcohol consumption group) ($N_{User\ and\ control}$=294; Median, 25%-75%, Range without outlier).

14.15.5 Attitudes

The subjects were asked several questions that refer to attitudes (Table 81; attitude towards drug use, attitudes towards DUI, motives against DUI, attitudes towards thresholds, general attitudes).

Table 81: Q-Start questions concerning subjects' attitudes.

Question
Attitude towards drug use
Which of the following drugs would you never take or would you never take again? (alcohol, cannabis, psilo-cybin, sniffing agents, cocaine, amphetamine, ecstasy, LSD, crack, heroin) yes/no **→ Willingness to use a substance (answers of controls → social acceptance)**
Attitudes towards DUI
How condemnable do you take driving under influence? (of one beer, cannabis, more than 4 beers, sedatives, amphetamine, cocaine, ecstasy, opiates, hallucinogens) 0=not at all …10=very much **→ Attitude towards DUI**
"If I know the driver had taken the following substances, I don't go with him." To what extent do you agree to this statement? 0=completely disagree...10=completely agree **→ Own opinion about riding along with an impaired driver**
Motives against DUI
How much does your decision to drive or not to drive after the consumption of drugs (incl. alcohol) depend on the following points? 0=not at all, 1=very little, 2=little, 3=medium, 4=much, 5=very much **→ Reasons for not driving after the consumption of drugs (detailed description of response options in Table 84 in Chapter 14.15.5.2)**

Attitudes towards thresholds
Do you favour a threshold for driving under the influence of cannabis? no/don't know/yes → **Attitude towards threshold for cannabis**
How many euros penalty would definitely prevent you from DUI? I would always drive/3,000 euros/1,000 euros/500 euros/100 euros/I never drive under influence → **Deterring effect of penalty**
Do you favour the new 0.00% BAC limit for young and novice drivers? Yes, better would be 0.00% for everyone Yes, I am in favour of it, it is safer I don't care No, I don't favour it, one beer should be permitted → **Attitude towards zero-tolerance for alcohol for young and novice drivers**
Which alcohol limit do you suggest for driving a motor vehicle? → **Desired alcohol limit**
How much do you think you have to drink to reach 0.1%? → **Perceived relation between amount of alcohol and BAC**
How much alcohol would you drink at maximum and still drive safely? → **Opinion about amount of alcohol to still drive safely**
General attitudes
How satisfied are you with your personal life situation on the whole? 0=totally dissatisfied...10=totally satisfied → **Life satisfaction (Satisfaction)**
To what extent do you agree to the following statement: "Someone who is always concerned with his health has no fun."? 0=completely agree…10=completely disagree (originally reversed polarity) → **Health awareness (HealthAware)**
To what extent do you agree to the following statement: "I try to eat only healthy food."? 0=completely disagree...10=completely agree → **Healthy nutrition (HealthFood)**
To what extent do you agree to the following statement: "If a constitutional state is to function, all laws have to be observed strictly!"? 0=completely disagree...10=completely agree → **Awareness of law (LawAware)**

14.15.5.1 Attitudes towards drug use and DUI

If the controls' willingness to use a substance is interpreted as general social acceptance, then the use of alcohol is highly socially accepted (98%), the use of cannabis is partly socially accepted (47%) and the use of other drugs is least socially accepted[69].

Figure 103 (left) shows the subject's attitude towards driving under the influence of different substances (N_{User}=194, $N_{Control}$=100). Users, much like controls, find it very much condemnable to drive under the influence of opiates and hallucinogens. While the controls' disapproval of driving after the consumption of amphetamine, cocaine or ecstasy is as high as their disapproval of driving after opiates and hallucinogens consumption, the users take driving under amphetamine and cocaine influence as condemnable as they take driving under the influence of more than four beers and

[69] Psilocybin: 15%, sniffing agents: 12%, cocaine: 13%, amphetamine: 11%, ecstasy: 10%, LSD: 10%, crack: 9%, heroin: 8%.

sedatives. Users find driving under ecstasy influence as condemnable as controls find driving after cannabis consumption and the consumption of more than four beers or sedatives. Users do not find it very condemnable to drive under the influence of cannabis. The lowest rates were found for drives after the consumption of one beer. For all substances except opiates and hallucinogens, the users' scores are lower than the controls' scores (Table 82).

It further turned out that the legal BAC limit has an effect on the controls' attitude towards driving after the consumption of one beer (Figure 103, right). 18-24-year-old controls for whom the zero-tolerance applies find it still not very much but to some degree more condemnable to drive after one beer than 18-24-year-old controls for whom the 0.05% BAC limit applies (t=1.70; p=0.096). For users, no effect was found.

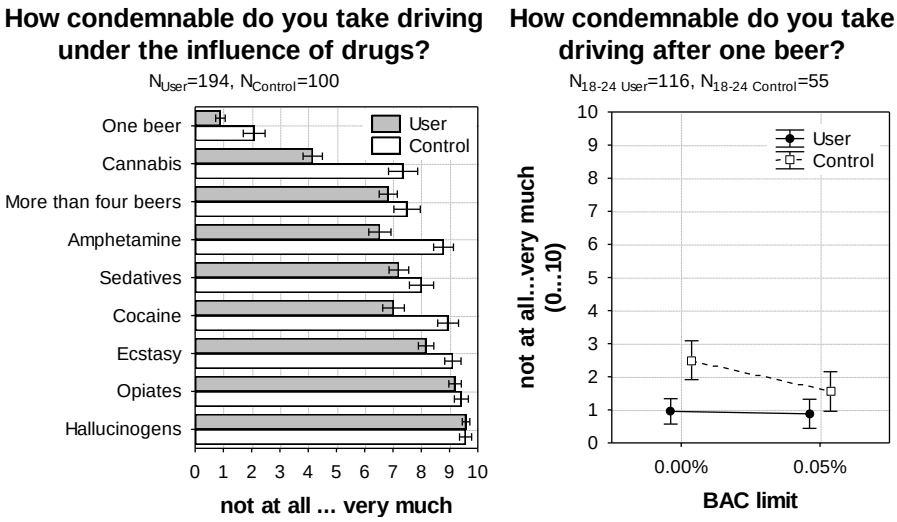


Figure 103: Attitude of users and controls towards DUI (under the influence of one beer, cannabis, more than 4 beers, sedatives, amphetamine, cocaine, ecstasy, opiates, hallucinogens; left, N_{User}=194, $N_{Control}$=100) and attitude of 18-24-year-old users and controls towards driving after one beer, depending on which BAC limit applies (right, $N_{18\text{-}24\ User}$=116, $N_{18\text{-}24\ Control}$=55) (Mean, ±0.95 CI).

Table 82: Mean (±0.95 CI) and statistics of attitude of users and controls towards driving under the influence of different substances (N_{User}=194, $N_{Control}$=100).

How condemnable do you take driving under influence? (0=not at all …10=very much)				
Substance	**Mean$_{User}$ (±0.95 CI)**	**Mean$_{Control}$ (±0.95 CI)**	**t**	**p-value**
One beer	0.9 (0.7-1.1)	2.1 (1.7-2.5)	-6.51	0.000
Cannabis	4.2 (3.8-4.5)	7.4 (6.8-7.9)	-10.5	0.000
More than four beers	6.8 (6.5-7.2)	7.5 (7-8)	-2.35	0.019
Sedatives	7.2 (6.9-7.6)	8 (7.6-8.4)	-2.77	0.006
Amphetamine	6.5 (6.1-6.9)	8.8 (8.4-9.1)	-7.4	0.000
Cocaine	7 (6.6-7.4)	9 (8.6-9.3)	-6.41	0.000
Ecstasy	8.2 (7.9-8.4)	9.1 (8.8-9.4)	-4.35	0.000
Opiates	9.2 (9-9.4)	9.4 (9.2-9.7)	-1.23	0.218
Hallucinogens	9.6 (9.5-9.7)	9.6 (9.4-9.8)	0.13	0.900

The subjects were further asked if they would go along with a driver of whom they knew that he had taken drugs (*one beer*, *cannabis*, *more than 4 beers*, *sedatives*, *amphetamine*, *cocaine*, *ecstasy*, *opiates*, *hallucinogens*; 0=low disapproval...10=high

disapproval). Users whose proportion of drives under influence of all drives concerning the substance in question is higher than the median proportion (*HighDUI*) are less adverse to go along with an intoxicated driver compared to users whose proportion of drives under influence is as high as the median or lower (*LowDUI*) (Figure 104). Whereas the difference is statistically significant when the question refers to a driver intoxicated by alcohol or cannabis, the result is only marginally significant when it refers to a driver intoxicated by stimulants (Table 83). The analysis is restricted to the main drugs under which the subjects drove while participating (alcohol, cannabis, stimulants).

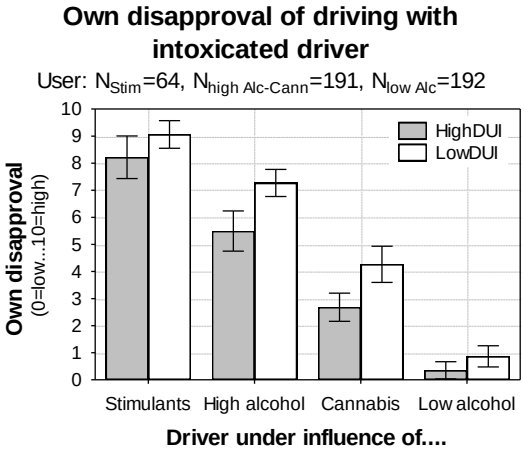


Figure 104: Own disapproval of driving with an intoxicated driver (Mean, ±0.95 CI; 0=low disapproval...10=high disapproval; under influence of stimulants, i.e. amphetamine/cocaine/ecstasy, high alcohol, i.e. more than four beers, cannabis, low alcohol, i.e. one beer), depending on the subjects' proportion of drives under influence of all drives (HighDUI=higher than median proportion, LowDUI= as high as median proportion or lower; under influence of stimulants, i.e. amphetamine/cocaine/ecstasy, high alcohol, i.e. BAC≥0.05%, cannabis, i.e. THC blood plasma level≥1ng/ml, low alcohol, i.e. BAC<0.05%).

Table 83: Mean (±0.95 CI) and statistics of own disapproval of driving with an intoxicated driver (under influence of stimulants, i.e. amphetamine/cocaine/ecstasy, high alcohol, i.e. more than four beers, cannabis, low alcohol, i.e. one beer).

Own disapproval of driving with an intoxicated driver (0=low disapproval...10=high disapproval)				
Substance	**Mean$_{HighDUI}$ (±0.95 CI)**	**Mean$_{LowDUI}$ (±0.95 CI)**	**t**	**p-value**
Stimulants	8.2 (7.4-9)	9.1 (8.6-9.6)	1.84	0.071
High alcohol	5.5 (4.8-6.2)	7.3 (6.8-7.8)	4.07	0.000
Cannabis	2.7 (2.2-3.2)	4.3 (3.6-4.9)	3.74	0.000
Low alcohol	0.4 (0.0-0.7)	0.9 (0.5-1.3)	2.03	0.044

14.15.5.2 Motives against DUI

Another question referred to possible reasons for not driving after the consumption of drugs. There were four thematically different categories of items for which the subjects had to indicate to what extent it influences their decision to drive when being intoxicated by psychoactive substances (Table 84; *Characteristics of drug intake*, *route characteristics*, *possible alternatives*, *social reasons*).

Table 84: Question concerning reasons for not driving after the consumption of drugs.

How much does your decision to drive or not to drive after the consumption of drugs (incl. alcohol) depend on the following points? (Response option: 0=not at all, 1=very little, 2=little, 3=medium, 4=much, 5=very much)	
Abbr.	**Scale and Items**
Drug	**Characteristics of drug intake**
D_1	…how much I have taken
D_2	…when I have taken the drug
D_3	…which drug/combination of drugs I have taken
D_4	…how roadworthy/tired I feel
Rout	**Route characteristics**
R_1	… the type of route (motorway, rural, city)
R_2	… the length of the route
R_3	… the level of familiarity with the route
R_4	… the density of controls on the route
Alte	**Possible alternatives**
A_1	…whether I have money for a taxi or not
A_2	…whether I can walk/take public transport or not
A_3	…whether I can go with someone or not
A_4	…whether I have to be at home the next morning or whether I can sleep over or not
A_5	…whether I need the car at home the next morning or not
Soci	**Social reasons**
S_1	…whether I have passengers who I could endanger or not
S_2	…whether I should take somebody home or not
S_3	…whether it bothers my passengers or not
S_4	…how sober I am compared to other potential drivers

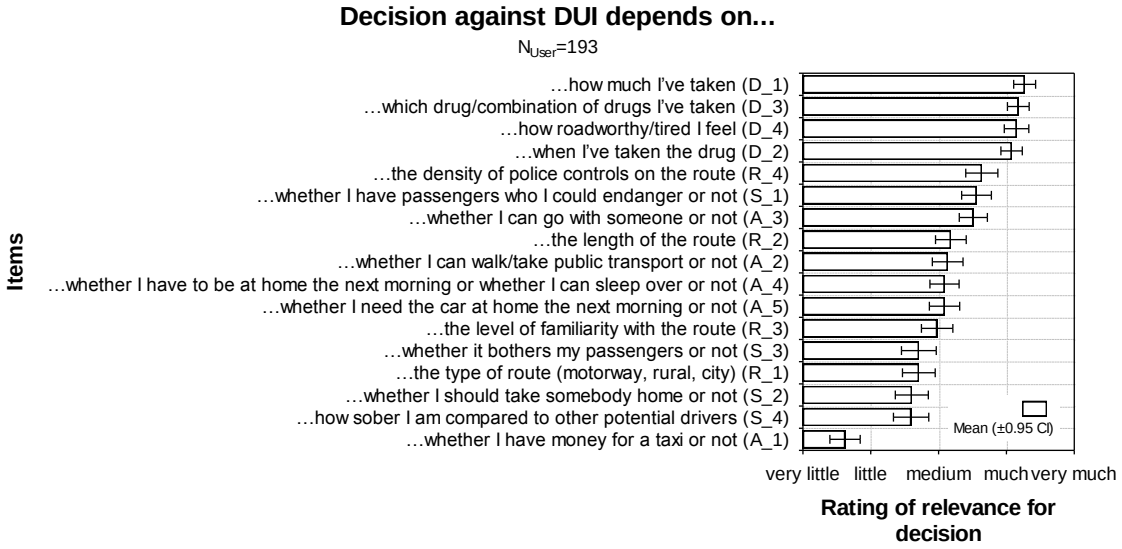


Figure 105: Reasons for deciding against DUI, sorted by their influence (very little, little, medium, much, very much; N_{User}=194; Mean, ±0.95 CI).

The decision to drive under influence is stated to mainly depend on characteristics of drug intake (amount of consumed drug, type of drug/drug combination, effect of consumed drug, time of drug consumption) (Figure 105). The density of police controls, whether passengers could be endangered and the possibility to ride along with another person are also quite relevant for the decision for or against DUI.

Possible alternatives to driving under influence, like walking, public transport, a low need to go home, a low need to have the car at home and some route characteristics (length of the route, familiarity with the route) are of middle importance for the decision to drive after drug consumption. The least important is whether the subject has money for a taxi or not, followed by most items that refer to social reasons (whether it bothers others, whether the subject has to take home another person, how sober other potential drivers are) and the the route characteristic "*type of route*".

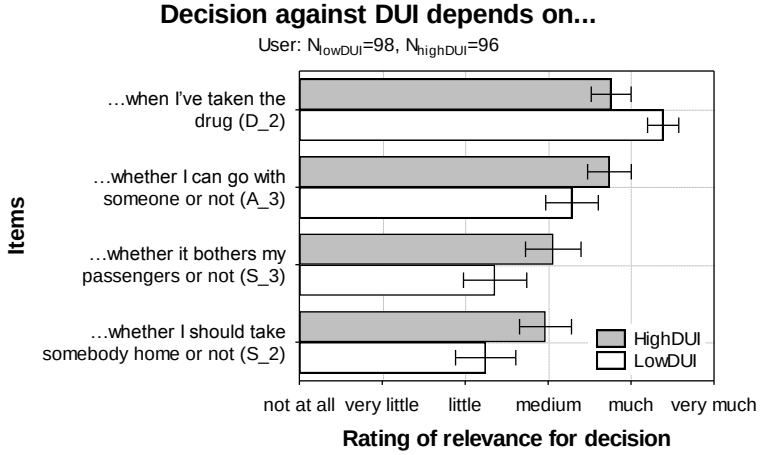


Figure 106: Significant differences of the relevance of reasons for decisions against DUI on item-level for those who committed DUI rather seldom (N_{LowDUI}=98) and those who committed DUI rather often ($N_{HighDUI}$=96) (Mean, ±0.95 CI).

Table 85: Mean rating (±0.95 CI) and statistics of the relevance of different reasons (different items, significant results) for decisions against DUI for those who committed DUI rather seldom (N_{LowDUI}=98) and those who committed DUI rather often ($N_{HighDUI}$=96).

How much does your decision to drive or not to drive after the consumption of drugs (incl. alcohol) depend on the following points? (0=not at all...5=very much)				
Significant items	**Mean$_{highDUI}$ (±0.95 CI)**	**Mean$_{lowDUI}$ (±0.95 CI)**	**t**	**p-value**
D_2	3.8 (3.5-4)	4.4 (4.2-4.6)	-4.09	0.000
A_3	3.7 (3.5-4)	3.3 (3-3.6)	2.17	0.031
S_3	3.1 (2.7-3.4)	2.4 (2-2.7)	2.74	0.007
S_2	3 (2.7-3.3)	2.2 (1.9-2.6)	2.98	0.003

Only few items were rated differently depending on how often users drive under influence (Figure 106, Table 85). Users whose proportion of DUI of all drives is rather low (*LowDUI*) state that the consumption time is more relevant to their decision to drive after consumption compared to users whose proportion of DUI is rather high (*HighDUI*). Those who often drive under influence state that whether or not they can go with someone, whether or not it bothers the other passengers and whether or not they should take others home carries more weight than it does for users who rather seldom drive under influence.

14.15.5.3 Attitudes towards thresholds

The subjects were asked if they would favour a threshold for driving under the influence of cannabis.

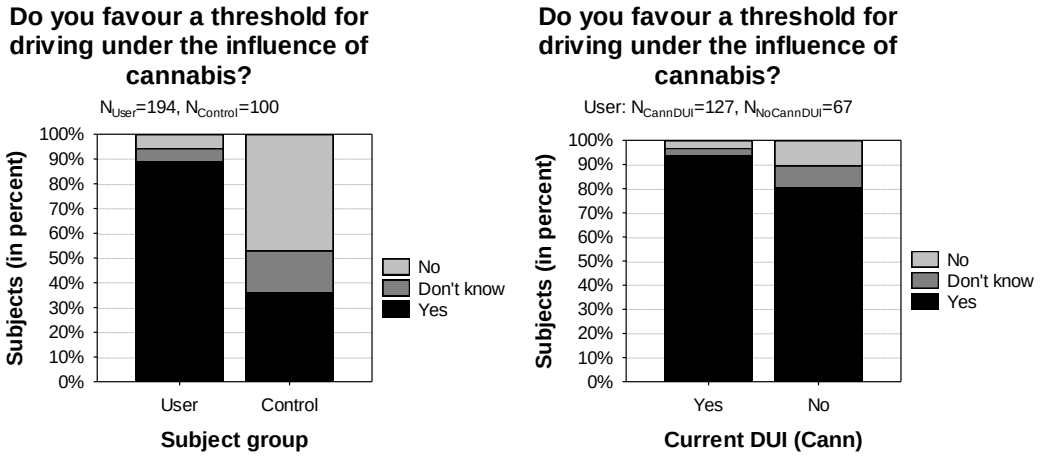


Figure 107: Percentage of being in favour of a threshold for driving under the influence of cannabis for users versus controls (left, N_{User}=194, $N_{Control}$=100) and current DUI-offenders (Cann) versus those who did not commit any THC-positive drive while participating (right, $N_{CannDUI}$=127, $N_{NoCannDUI}$=67).

Only 36% of the controls answered "yes", whereas most users (89.2%) stated that they were in favour (Figure 107, left; Table 86). The most frequently specified reasons were the long traceability of the substance in body fluids and a feeling of injustice compared to persons who drink and drive. Users who drove under the influence of cannabis while participating in the study are in favour of a threshold, whereas users who would not be affected by a threshold because they currently were not driving after cannabis consumption are less positive about it (Figure 107, right; Table 86).

Table 86: Percentage (±0.95 CI) and statistics of being in favour of a threshold for driving under the influence of cannabis for users versus controls (N_{User}=194, $N_{Control}$=100) and current DUI-offenders (Cann) versus those who did not commit any THC-positive drive while participating ($N_{CannDUI}$=127, $N_{NoCannDUI}$=67).

In favour of a threshold for driving under the influence of cannabis (versus don't know/no)			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
89.2% (84.8%-93.5%)	36% (26.6%-45.4%)	90.78 (1)	0.000
$Percent_{CannDUI}$ (±0.95 CI)	**$Percent_{NoCannDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
93.7% (89.5%-98%)	80.6% (71.1%-90.1%)	7.8 (1)	0.005

The users were also asked how high the penalty would have to be to restrain them from driving under the influence of illegal drugs. Users who had no/very few drives under influence (*LowDUI*) answered in 26.8% of the cases that they never drive under influence and in 17.5% of the cases that they would always drive, no matter how high the penalty was. Of the users who had a high proportion of drives under influence of all drives (*HighDUI*), 4.1% stated that they would never drive and 30.9% stated that they would always drive (Figure 108). Of the remaining subjects (N_{LowDUI}=54, $N_{HighDUI}$=63), 72.2% of the LowDUI-group stated that a penalty of up to 500 euros would deter them from intoxicated driving compared to around 50% in the HighDUI-group (Table 87). The other 50% of the latter group said that they would only be deterred from DUI when the penalty was 1,000 euros and higher.

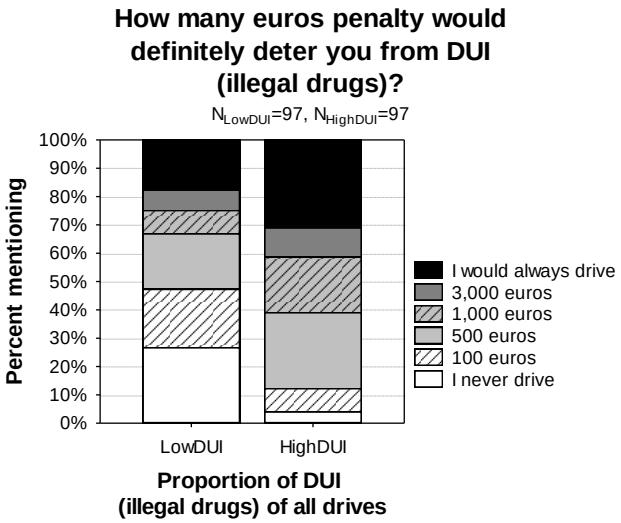


Figure 108: Percentage of being deterred from DUI by different penalty levels for those who had a higher proportion of DUI (illegal drugs) of all drives than the median ($N_{HighDUI}$=97) and those who had a lower proportion (N_{LowDUI}=97).

Table 87: Percentage (±0.95 CI) and statistics of being deterred from DUI by a penalty of less than 1,000 euros for those who had a higher proportion of DUI (illegal drugs) of all drives than the median ($N_{HighDUI}$=54) and those who had a lower proportion (N_{LowDUI}=63).

Being deterred from DUI by a penalty of less than 1,000 euros (versus 1,000 euros and more)			
$Percent_{HighDUI}$ (±0.95 CI)	**$Percent_{LowDUI}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
54% (37.2%-70.7%)	72.2% (58.2%-86.3%)	4.18 (1)	0.041

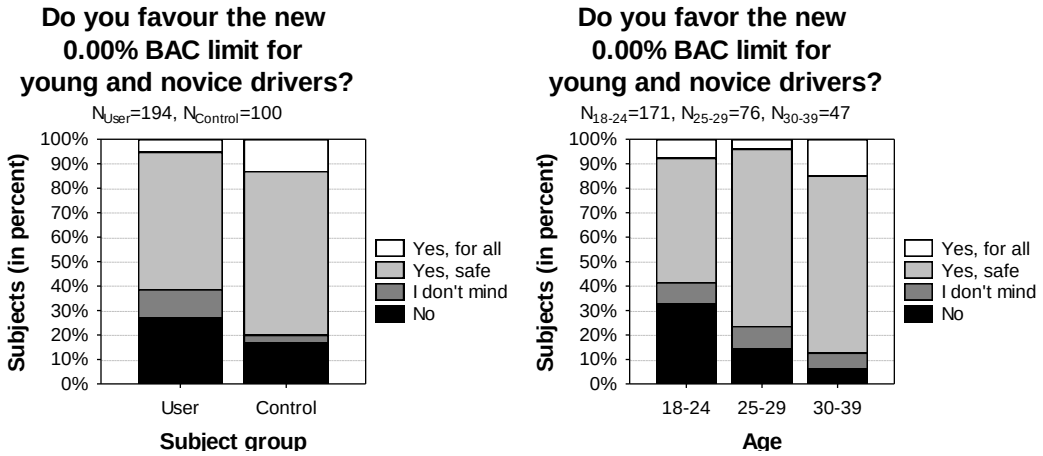


Figure 109: Percentage of being in favour of the new 0.00% BAC limit for young and novice drivers for users versus controls (left, N_{User}=194, $N_{Control}$=100) and 18-24-year-olds versus 25-29- and 30-39-year-olds (right, N_{18-24}=171, N_{25-29}=76, N_{30-39}=47).

Another question referred to the subjects' acceptance of the implementation of the zero-tolerance for young and novice drivers for driving under alcohol influence. 80% of the controls answered "yes, better would be 0.00% for everyone" (*yes, for all*) or "yes, I am in favour of it, it is safer" (*yes, safe*) (Figure 109, left; Table 88). Of the users, only 61.3% advocate the zero-tolerance. With reference to different age groups (Figure 109, right; Table 88), again, those subjects whom it concerns the most are

less enthusiastic about the zero-tolerance. 58.5% of the 18-24-year-olds approve of the zero-tolerance compared to 80.5% of the 25-39-year-olds.

Table 88: Percentage (±0.95 CI) and statistics of being in favour of the new 0.00% BAC limit for young and novice drivers for users versus controls (N_{User}=194, $N_{Control}$=100) and 18-24-year-olds versus 25-39-year-olds (N_{18-24}=171, N_{25-39}=123).

In favour of the new 0.00% BAC limit for young/novice drivers ("*yes, for all*", "*yes, safe*" versus "*I don't mind*", "*no*")			
$Percent_{User}$ (±0.95 CI)	**$Percent_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
61.3% (54.5%-68.2%)	80% (72.2%-87.8%)	10.5 (1)	0.001
$Percent_{18-24}$ (±0.95 CI)	**$Percent_{25-39}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
58.5% (51.1%-65.9%)	80.5% (73.5%-87.5%)	15.84 (1)	0.000

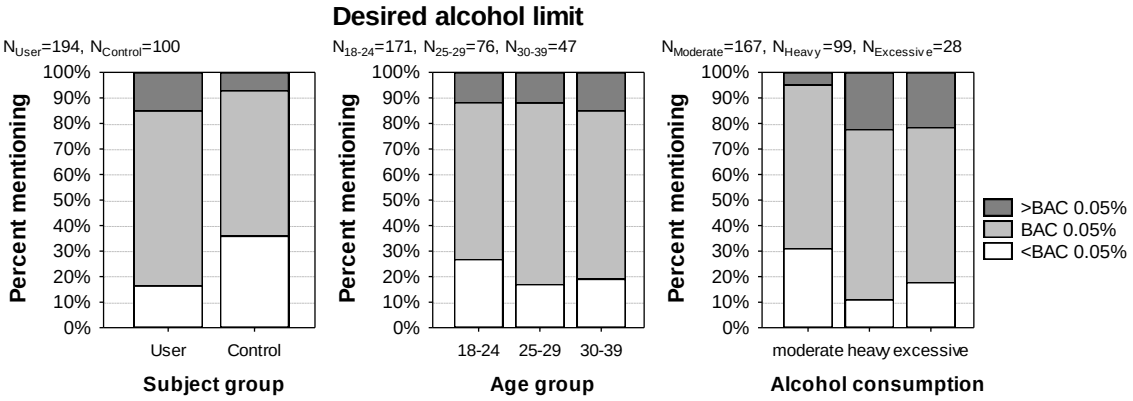


Figure 110: Percentage of different levels of desired alcohol limit (>BAC 0.05%, BAC 0.05%, <BAC0.05%) for users/controls (left), for 18-24-year-olds/25-29-year-olds/30-39-year-olds (middle) and moderate/heavy/excessive alcohol users (right) (Number of subjects see in figure).

Table 89: Percentage (±0.95 CI) and statistics of a desired alcohol limit of <BAC 0.05% for users/controls, 18-24-year-olds/25-29-year-olds/30-39-year-olds, moderate/heavy/excessive alcohol users (Number of subjects see in Figure 110).

Percentage of desired alcohol limit lower than 0.05% (analysis over all categories)				
Subject group				
	Perc. $_{User}$ (±0.95 CI)	**Perc.$_{Control}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
	16.5% (3.6%-29.4%)	36% (20.3%-51.7%)	15.35 (2)	0.000
Age group				
Perc.$_{18-24}$ (±0.95 CI)	**Perc.$_{25-29}$ (±0.95 CI)**	**Perc.$_{30-39}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
26.9% (14.7%-39.7%)	17.1% (-)	19.1% (-)	3.72 (4)	0.445
Alcohol consumption				
Perc. $_{Moderate}$ (±0.95 CI)	**Perc. $_{Heavy}$ (±0.95 CI)**	**Perc.$_{Excessive}$ (±0.95 CI)**	**chi-square (df)**	**p-value**
31.1% (18.6%-43.7%)	11.1% (-)	17.9% (-)	30.27 (4)	0.000

The subjects were further asked which alcohol limit they would suggest for driving a motor vehicle. The answers were divided into the classes *<BAC 0.05%*, *BAC 0.05%* and *>BAC 0.05%*. Controls more often took the view that the legal BAC limit should be lower than 0.05% compared to users (Figure 110, left; Table 89). The same is true for moderate alcohol users compared to heavy and excessive alcohol users (Figure

110, right; Table 89)[70]. When comparing the subjects according to their age, no significant differences got apparent (Figure 110, middle; Table 89).

The subjects were further asked to indicate how much beer, wine and/or liquor they would have to drink to reach a BAC of 0.1% and how much they can drink at maximum and still be able to drive safely. The stated amount of alcoholic beverages was converted into grams of alcohol. For the graphic presentation (Figure 111) of the statements depending on the consumption group (*moderate*, *heavy*, *excessive alcohol users*), the converted grams of alcohol were further categorised into 20 grams categories (*<20 grams*, *20-40 grams*… *≥140 grams*). For the analysis, the original converted values in grams of alcohol were used (Table 90).

According to the Widmark Formula (Widmark, 1932), a person has to drink 60-80 grams of alcohol in three hours to reach a BAC of 0.1% and 30-40 grams of alcohol in one and a half hours to reach a BAC of 0.05%. Around 60% of moderate and heavy alcohol users think that a person has to drink 80 grams of alcohol at maximum to reach a BAC of 0.1% (Figure 111, left). Excessive users more often assume that a higher amount is necessary to reach this BAC level. 80% of the moderate users stated to be able to drink 40 grams of alcohol at a maximum and still drive safely, whereas 50% and more of the heavy and excessive users stated higher alcohol amounts (Figure 111, right). The corresponding analysis reached significance (Table 90).

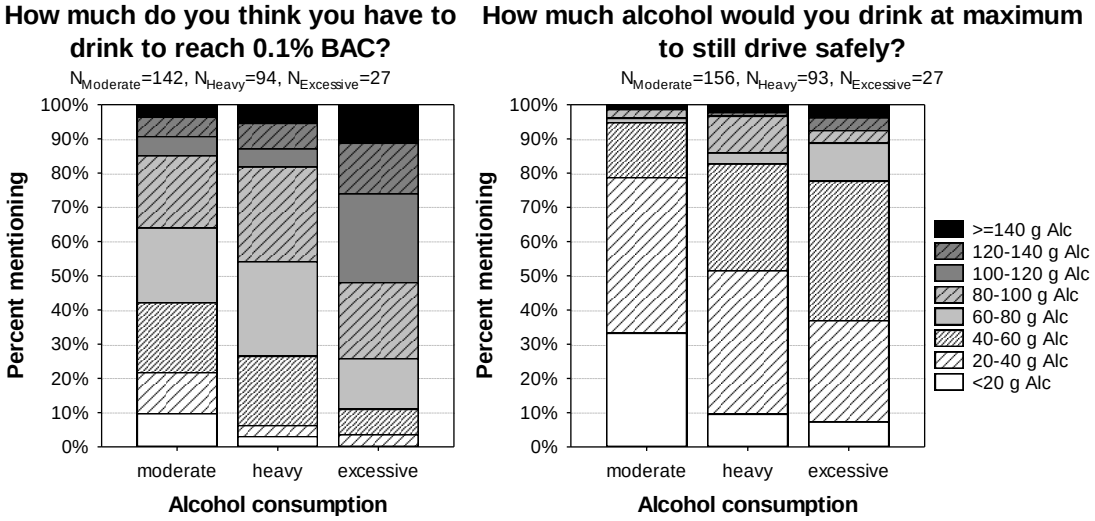


Figure 111: Percentage of different categories of amount of alcohol (in grams of alcohol) to reach 0.1% BAC (left) and to still drive safely (right) for moderate, heavy, excessive alcohol users (Number of subjects see in figure).

[70] Moderate use (N=167): ≤24 g/day (male), ≤12 g/day (female);
Heavy use (N=99): >24-60 g/day (male), >12-40 g/day (female);
Excessive use (N=28): >60 g/day (male), >40 g/day (female).

Table 90: Estimated mean and statistics of amount of alcohol (in grams of alcohol; ±0.95 CI) to reach 0.1% BAC and to still drive safely for moderate, heavy, excessive alcohol users (Number of subjects see in Figure 111).

Estimated mean amount of alcohol to reach 0.1% BAC and to still drive safely					
	$Mean_{Moderate}$ (±0.95 CI)	**$Mean_{Heavy}$ (±0.95 CI)**	**$Mean_{Excessive}$ (±0.95 CI)**	**F**	**p-value**
0.1% BAC	63.2 (57-69.4)	72.2 (65.8-78.6)	94.7 (81.1-108.4)	9.61	0.000
Drive safely	25 (20.5-29.4)	38.8 (33-44.7)	43.9 (31-56.7)	9.62	0.000

14.15.5.4 General attitudes

The following questions refer to general attitudes:

- How satisfied are you with your personal life situation on the whole? (*Satisfaction*)
  High scale value → high satisfaction
- To what extent do you agree to the following statement: "Someone who is always concerned with his health has no fun."? (*HealthAware*)
  High scale value → high health awareness
- To what extent do you agree to the following statement: "I try to eat only healthy food."? (*HealthFood*)
  High scale value → high healthy nutrition
- To what extent do you agree with the following statement: "If a constitutional state is to function, all laws have to be observed strictly!"? (*LawAware*)
  High scale value → high awareness of law

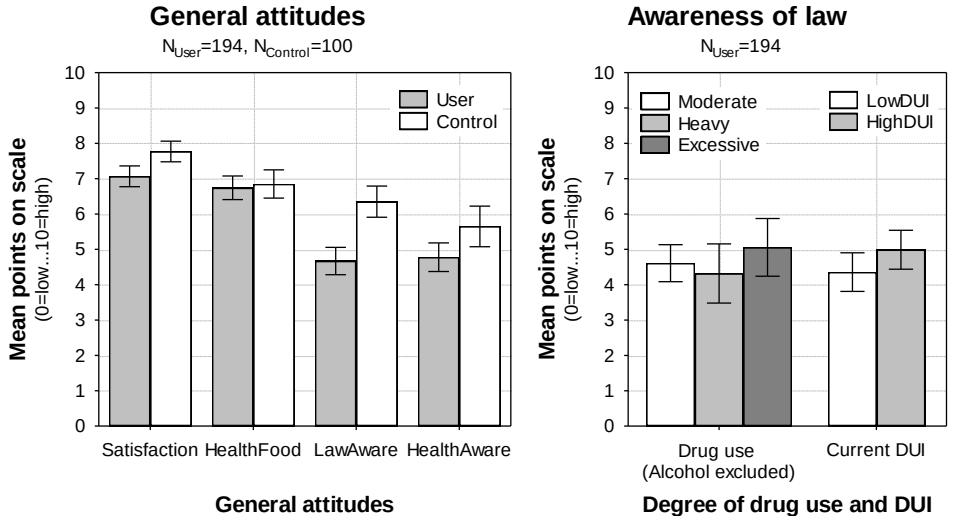


Figure 112: General attitudes (satisfaction, healthy nutrition, law awareness, health awareness) of users (N_{User}=194) and controls ($N_{Control}$=100) and law awareness of moderate/heavy/excessive users and frequent/infrequent drug drivers (LowDUI/HighDUI) (Mean, ±0.95 CI).

Users (N_{User}=194) compared to controls ($N_{Control}$=100) are less satisfied with their personal life situation, are less convinced that obeying the law is beneficial in a constitutional state and are less aware of a healthy way of life (Figure 112, left; Table 91). The subjects' general intention to eat healthy food does not differ between users and controls. One presumption, when analysing influencing factors of illegal behaviour (use of illegal drugs, drug driving), is a perceived effect of the attitude towards compliance with the law on the degree of illegal behaviour. When comparing

moderate, heavy and excessive users ($N_{Moderate}$=100, N_{Heavy}=41, $N_{Excessive}$=53) of illicit drugs[71] with each other and those users who frequently drive under influence[72] with those who rather infrequently drive under influence (N_{LowDUI}=98, $N_{HighDUI}$=96), no distinct differences depending on the degree of law awareness could be shown (Figure 112, right; Table 91).

Table 91: Mean (±0.95 CI) and statistics of general attitudes (satisfaction, healthy nutrition, law awareness, health awareness) of users and controls (N_{User}=194, $N_{Control}$=100), mean (±0.95 CI) and statistics of law awareness of moderate/heavy/excessive users and frequent/infrequent drug drivers (LowDUI/HighDUI) (Number of subjects see in text above).

General attitudes				
	$Mean_{User}$ (±0.95 CI)	**$Mean_{Control}$ (±0.95 CI)**	**F**	**p-value**
Satisfaction	7.1 (6.8-7.4)	7.8 (7.5-8.1)	9.05	0.003
Healthy nutrition	6.7 (6.4-7.1)	6.8 (6.4-7.3)	0.15	0.698
Law awareness	4.8 (4.4-5.2)	5.6 (5.1-6.2)	28.15	0.000
Health awareness	4.7 (4.3-5.1)	6.4 (5.9-6.8)	6.05	0.014
Law awareness				
$Mean_{Moderate}$ (±0.95 CI)	**$Mean_{Heavy}$ (±0.95 CI)**	**$Mean_{Excessive}$ (±0.95 CI)**	**F**	**p-value**
4.6 (4.1-5.1)	4.3 (3.5-5.2)	5.1 (4.2-5.9)	0.90	0.410
	$Mean_{LowDUI}$ (±0.95 CI)	**$Mean_{HighDUI}$ (±0.95 CI)**	**F**	**p-value**
	4.4 (3.8-4.9)	5 (4.4-5.5)	2.62	0.107

14.16 Deterrence effect of sanctioning and enforcement

14.16.1 Legal binding consequences for getting caught in Germany

The legal consequences in Germany for getting caught while driving under influence are shown in Table 92. In February 2009, the fines for traffic offences were doubled. Former fines are also listed in Table 92 (in brackets).

The offences are differentiated between administrative and criminal offences. In the case of illegal drugs and a BAC between 0.03% and less than 0.11%, the prerequisite for a criminal sentence is the occurrence of signs of impairment. A BAC of 0.11% and more is always treated as a criminal offence. If someone gets caught with a BAC of 0.16% and higher and in most of the cases when someone gets caught while driving under the influence of illegal drugs, a medical and psychological assessment (MPA) is ordered because the fitness to drive is regarded as questionable.

[71] Illicit drug use: use of illegal drugs and/or abuse of prescription medicines (alcohol excluded).
[72] Drives under influence: drives under influence of illegal drugs and/or prescription medicines and/or alcohol above the legal limit (BAC 0.00% for young and novice drivers and BAC 0.05% for all other drivers, respectively).

Table 92: Legal consequences for driving under the influence of drugs or alcohol in Germany.

Administrative offence § 24 StVG[73] (§ 24c for BAC 0.00% | § 24a for BAC 0.05% and drugs)	**Criminal offence § 316 StGB[74]**	**MPA § 14 FeV[75]**
drugs (zero-tolerance) Signs of impairment		
4 demerit points 500 (1st offence) -1,500€ (3rd offence) (before 01.02.2009: 250-750€) 1 (1st offence) - 3 (2nd, 3rd offence) months driving ban	7 demerit points Penalty or prison up to 1 year Withdrawal (6 months to 5 years)	very likely
BAC 0.00% for all drivers younger than 21 and newly licensed drivers for the first two years of having a licence		
2 demerit points 250€ (before 01.02.2009: 125€) no driving ban, but rehabilitation programme and extension of probationary licence (2 years)		
BAC 0.03% From BAC 0.03% on and signs of impairment		
(neither administrative nor criminal offence, but partial liability in the case of a not self-inflicted accident)	7 demerit points Penalty or prison up to 1 year Withdrawal (6 months to 5 years)	
BAC 0.05%		
4 demerit points 500 (1st offence) -1,500€ (3rd offence) (before 01.02.2009: 250-750€) 1 (1st offence) - 3 (2nd, 3rd offence) months driving ban		
BAC 0.11%		
	7 demerit points Penalty or prison up to 1 year Withdrawal (6 months to 5 years)	
BAC 0.16% (also for cycling)		
	7 demerit points Penalty or prison up to 1 year Withdrawal (6 months to 5 years)	very likely
In the case of **endangerment** or an **accident** drives at all BACs above the respective limit and all drives under the influence of drugs **§ 315c StGB**		
	7 demerit points Penalty or prison up to 5 years Withdrawal (>1 year)	

14.16.2 Knowledge about legislation

The subjects' knowledge about the legal consequences that are faced when driving under influence and the subjective sanction severity were queried by open questions at the last contact (N=293[76]) (Table 93).

[73] Straßenverkehrsgesetz: German Road Traffic Act.
[74] Strafgesetzbuch: German Penal Code.
[75] Fahrerlaubnisverordnung: German Driver Licensing Act.
[76] Two subjects did not deliver information because they left the study ahead of time. In these cases, no detailed final inquiry was carried out.

Table 93: Q-End questions concerning the knowledge about legislation and the subjective sanction severity.

Questions
A driver took drugs and drives under influence. He gets caught by the police. He has no drugs on his person, showed no driving mistakes or substantial deficits and was not involved in an accident. What do you think are the legal consequences? Please name everything that comes into your mind. What is the legal BAC limit in Germany? A driver drives with a higher BAC than that and gets caught by the police. The person showed no driving mistakes or substantial deficits and was not involved in an accident. What do you think are the legal consequences? Please name everything that comes into your mind. Are there any other BAC limits in Germany? If yes, which one? And what are the consequences when driving with a higher BAC? **→ Knowledge about legislation**
How severe do you rate the just mentioned sanctions (for drugs and each mentioned BAC limit separately)? 0=not severe ... 10=very severe **→ Subjective sanction severity**

14.16.2.1 Data overview and data preparation

In 4.1% (N=44) of all mentioned offences[77], the subjects did not know what consequences are to be expected when driving under the influence of illegal drugs or with a BAC above the mentioned limit. In all other cases they most often stated a driving ban (76%) and a fine (70.6%). They least often stated demerit points (44.3%) (light and dark grey bars Figure 114). The light grey bars refer to cases when subjects mentioned the consequence but did not specify the extent in months (driving ban), euros (fine) and number of points (demerit points), respectively. The plain bars refer to cases when subjects additionally (or solely in the case of *no* driving ban/fine/demerit points) mentioned a MPA or withdrawal as consequence. The proportions of mentioning a MPA/withdrawal are quite comparable for the different conditions concerning a fine and demerit points and also for the detailed mentioning of a driving ban in months (dark grey bar, #1). But when the subjects did not mention a driving ban, the mentioning of a MPA/withdrawal was quite unlikely (white bar, #1), whereas in almost all the cases when the subjects mentioned a driving ban but did not specify the extent, they additionally mentioned a MPA/withdrawal (light grey bar, #1). In these cases and in the case that no driving ban but withdrawal was mentioned, the missing information about the duration of the driving ban/withdrawal was set to 6 months for further analysis.

In the case that young or novice drivers get caught while driving under the influence of alcohol (BAC<0.05%), no driving ban is imposed, but the driver has to participate in a rehabilitation programme and the probationary period becomes extended for an additional two years. Figure 113 shows that in 73% of the cases the subjects mentioned either a rehabilitation programme or the extension of the probationary period as a consequence for getting caught with a BAC above zero as young or novice driver. For all other BAC limits and for driving under the influence of drugs,

[77] $N_{Offences}$=1070; 293 refer to illegal drugs; 777 refer to alcohol, i.e. on average 2.7 mentioned BAC limits per person (those mentioned BAC limits that could not be assigned to any of the existing BAC limits in Germany are not included therein; N=8).

these consequences were stated rather infrequently. When analysing the correctness of the mentioned consequences (Chapter 14.16.2.3), the specification of no driving ban for young and novice drivers when driving under the influence of alcohol is only regarded as correct in combination with the mentioning of either a rehabilitation programme or the extension of the probationary period (*reha/prob*).

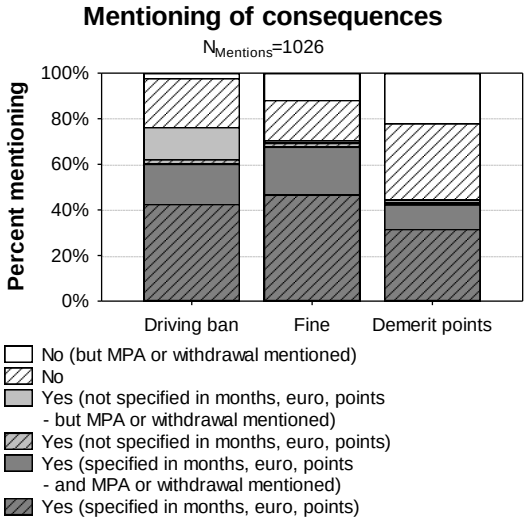


Figure 114: Percentage of mentioning driving ban, fine and demerit points as consequence (yes, no), depending on if additionally a MPA and/or withdrawal was mentioned and if the extent was specified in months, euros and number of points, respectively ($N_{Mentions}$=1026).

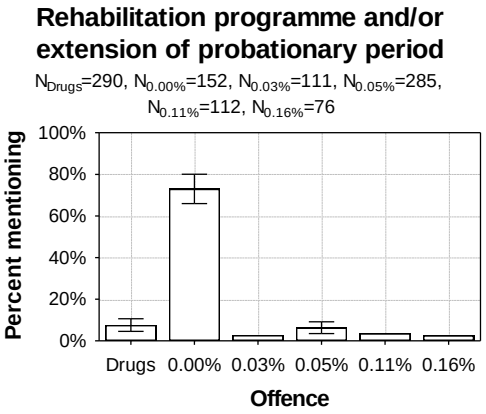


Figure 113: Percentage of mentioning the participation in a rehabilitation programme and/or the extension of the probationary period as consequence of driving under the influence of drugs or with a BAC above the different BAC limits (0.00% for young and novice drivers; 0.05% for all other drivers; 0.03%, 0.11%, 0.16% for all drivers; ±0.95 CI; Number of cases see in figure).

In addition to the above described consequences, Table 94 shows all other consequences that were mentioned. Further criminal proceedings (17.7%) and a blood (7.7%) or urine test (3.8%) were mentioned quite often, whereas the remaining consequences were rather infrequently mentioned.

Table 94: Type of mentioned consequences for DUI and percent of mentioning (±0.95 CI).

Kind of consequence	Percent of mentioning	±0.95 CI
Driving ban	76%	73.4%-78.6%
Fine	70.6%	67.8%-73.4%
Demerit points	44.3%	41.3%-47.3%
Further criminal proceedings	17.7%	15.4%-20%
Rehabilitation programme/extension of probationary period	15.6%	13.4%-17.8%
Blood test	7.7%	6.1%-9.3%
Urine test	3.8%	2.6%-5%
Search warrant (house or car)	1.9%	1.1%-2.7%
Order to leave the car	1.4%	0.7%-2.1%
Community service	1.3%	0.6%-2%
Prison	0.2%	-
Sobering-up cell	0.1%	-

14.16.2.2 Number of mentioned BAC limits

In Germany, there are five BAC limits that regulate driving under the influence of alcohol. Most subjects mentioned two (36.5%) or three (36.5%) different BAC limits (Figure 115). Eight of 293 subjects mentioned all BAC limits that exist in Germany (2.7%)[78].

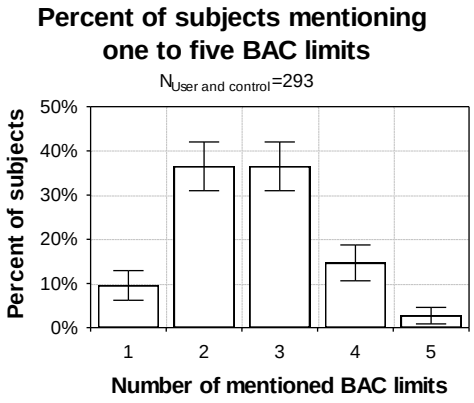


Figure 115: Percentage of subjects who mentioned one to five different BAC limits within the German legislation (±0.95 CI; $N_{User\ and\ control}$=293).

The most often stated BAC limit was 0.05% (N=288; 98.3%; Figure 116, left). The second most frequently mentioned BAC limit was the zero-tolerance for young and novice drivers (N=157; 53.6%) – although it was mentioned quite rarely compared to the 0.05% BAC.

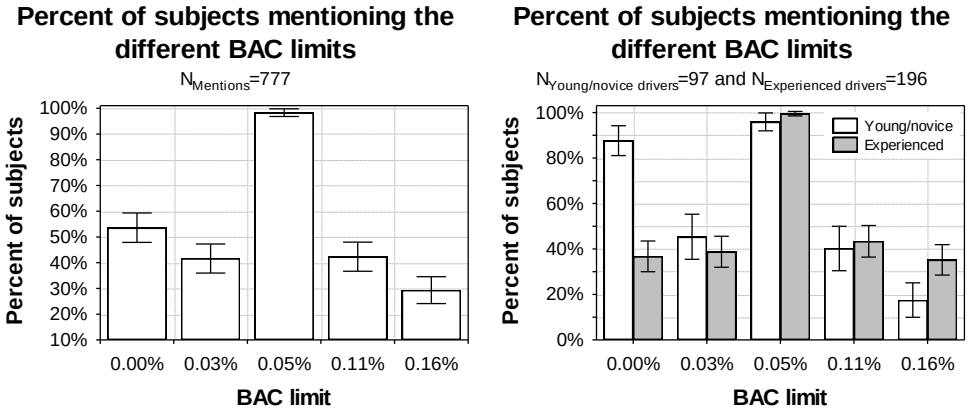


Figure 116: Percentage of subjects who mentioned the different BAC limits of all subjects (left figure, $N_{Mentions}$=777), also separated for young/novice and experienced drivers (right figure; BAC limit 0.00%, N=97; BAC limit 0.05%, N=196) (±0.95 CI).

Nevertheless, when comparing young and novice drivers (BAC limit 0.00%) with experienced drivers (BAC limit 0.05%) (Figure 116, right), a clear difference was

[78] 3 users (1.5% of all users) versus 5 controls (5%); all aged 18-29 years; 7 males (3.8%) versus 1 female (0.9%); 5 moderate to heavy alcohol users (2.1%) versus 3 excessive alcohol users (10.7%).

found. Drivers for whom the zero-tolerance applies mentioned it much more often (87.6%) than drivers for whom it does not apply (36.7%). Moreover, 12.4% of the young and novice drivers did not know that for them the zero-tolerance applies. Among others, they mentioned the 0.05% BAC limit. The 0.03% and 0.11% BAC limit were mentioned by around 40% of the subjects. Here, young and novice drivers did not differ from experienced drivers. Around 60% of those who named the 0.03% BAC limit referred to circumstances in which the driver does not make mistakes but is involved in an accident and is therefore punished by the insurance. The remaining 40% refer to situations in which the driver shows signs of impairment and gets punished by the criminal law even if the BAC is rather low. The 0.16% BAC limit was mentioned least frequently (29.4%) and by experienced drivers more often (28.5%) than by young and novice drivers (17.5%). In 5.3% of the cases the subjects mentioned a BAC limit but did not know which consequences would follow when driving with a higher BAC. This was most often the case for the BAC limits 0.03% (9%), 0.11% (9.7%) and 0.16% (11.6%) (BAC limit 0.00%: 3.2%; BAC limit 0.05%: 1%; illegal drugs: 1%).

Almost all the subjects that mentioned the BAC limit for young and novice drivers correctly assessed it to be 0.00% (96.8%; Figure 117). The 0.03% and 0.05% BAC limit was assessed correctly in around 80% of the cases. Around 15% thought these two BAC levels were lower and around 5% thought they were higher. The worst assessment refers to the 0.11% BAC limit. Here, 46.8% of the subjects thought it would be lower and 30.6% thought it would be higher. The percentage of those who thought the limit was higher was only 14.1% when mentioning the BAC limit of 0.16%. The correct assessment was higher for this BAC limit (41.2%) compared to the 0.11% BAC limit (22.6%)

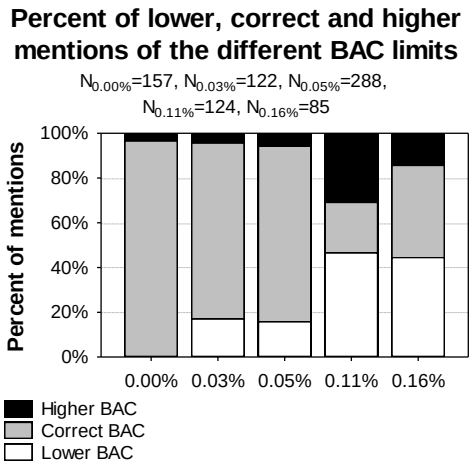


Figure 117: Percentage of lower, correct and higher mentions of the different BAC limits (0.00%, 0.03%, 0.05%, 0.11%, 0.16%; Number of cases see in figure).

14.16.2.3 Correctness of mentioned consequences

It was analysed whether the subjects know the legal consequences of getting caught correctly or if they assess it to be higher or lower. This analysis is reduced to the main BAC limits (0.00%, 0.05%, 0.11%) and illegal drugs. The correctness of the

expected consequences was depicted by the mentioning or not mentioning of a driving ban, the order of an MPA, fines, demerit points and subsequent criminal proceedings. All other mentioned consequences were too infrequently mentioned and were therefore ignored. Then, it was defined how much the statements could range from the true value (i.e. number of months of driving ban, amount of money as fine, etc.). In Table 95 these ranges can be seen in each second column of the listed consequences.

Table 95: Expected consequences for DUI in Germany.

	Driving ban (in months)		**MPA**		**Driving ban (in months) and MPA**		**Fine (in €)**		**Demerit points**		**Criminal proceedings**	
drugs (zero-tolerance)												
M*/DK**	1.7%		1%		1.7%		3.4%		3.8%		1%	
lower	12.3%	<1	42%	no	32.8%	<6 and MPA =0	41.3%	(<125) <250	68.3%	<3	68.6%	no
correct	**25.9%**	1-2	**57%**	yes	**65.5%**	≥6 & MPA=0 | MPA=1	**32.4%**	(125-375) 250-750	**23.5%**	3-4	**30.4%**	yes
higher	60.1%	>2					22.9%	(>375) >750	4.4%	>4		
BAC 0.00% for all drivers younger than 21 and newly licensed drivers for the first two years of having a licence												
M*/DK**	7%		3.2%		7%		5.7%		4.5%		3.2%	
lower	3.2%	0 & Reh/Prob=0			2.5%	0 & MPA=0 & Reh/Prob=0	41.4%	(<60) <125	59.9%	0		
correct	**34.4%**	0 & Reh/Prob=1	**76.4%**	no	**29.9%**	0 & MPA=0 & Reh/Prob=1	**24.2%**	(60-190) 125-375	**15.3%**	1-2	**89.8%**	no
higher	55.4%	>0	20.4%	yes	60.5%	>0 | 0 & MPA=1	28.7%	(>190) >375	20.4%	>2	7%	yes
BAC 0.05%												
M*/DK**	3.1%		1%		3.1%		5.6%		2.8%		1%	
lower	19.8%	<1			19.4%	<1 & MPA=0	37.8%	(<125) <250	62.2%	<3		
correct	**51%**	1-2	**86.5%**	no	**47.2%**	1-2 & MPA=0	**37.8%**	(125-375) 250-750	**31.3%**	3-4	**90.6%**	no
higher	26%	>2	12.5%	yes	30.2%	>2 & MPA=0 | MPA=1	18.8%	(>375) >750	3.8%	>4	8.3%	yes
BAC 0.11%												
M*/DK**	9.7%		9.7%		9.7%		12.1%		12.1%		9.7%	
lower	31.5%	<6			23.4%	<6 & MPA=0	63.7%	≤750	71%	<5	59.7%	no
correct	**58.9%**	≥6	**50.8%**	no	**27.4%**	≥6 & MPA=0	**24.2%**	>750	**16.9%**	5-9	**30.6%**	yes
higher			39.5%	yes	39.5%	MPA=1			0%	>9		

*M= Missing (mentioned, but without specification and MPA/Withdrawal not mentioned).
**DK=”Don’t know”.

If someone gets caught while driving under the influence of illegal drugs, in most of the cases a MPA is ordered. An MPA is accompanied by a withdrawal of the driving licence until the MPA is positively passed. So, even if the driving ban is actually only one month in accordance with § 24a StVG, the driving licence is in most of the cases withdrawn for around one year (until an ordered MPA is positively passed). Therefore, these two penalties – withdrawal and MPA – were examined together (Table 95, column *Driving ban (in months) and MPA*). Besides, in the case of illegal drugs the probability that criminal proceedings follow – either according to the StGB[79]

[79] Strafgesetzbuch: German Penal Code.

or the BtMG[80] – is rather high. So, the specification of further criminal proceedings for illegal drugs was considered to be right. With respect to the 0.00% BAC limit, the participation in a rehabilitation programme and the extension of the probationary period (*Reh/Prob*) were also regarded when classifying the mentioning of the driving ban correct or lower (as already mentioned in Chapter 14.16.2.1). The fines were classified according to the fines prior to the 1st February 2009 or the fines after that date, depending on when the interview was conducted. The correct ranges that refer to the former fines are shown in brackets.

60.1% of the subjects expect a higher driving ban than the one that is actually imposed when being caught while driving under the influence of illegal drugs. 57% expect the order of a MPA. As mentioned above, a MPA is quite likely in the case of drug offences and is accompanied by a withdrawal of the driving licence. So, a driving ban of more than six months and/or the order of a MPA were regarded as correct answer. This was mentioned by 65.5% of the subjects. For the violation of the 0.00% BAC limit most subjects expect a higher driving ban than the one that is actually imposed (55.4%). Most subjects (76.4%) correctly did not mention a MPA. In sum, only 29.9% of the subjects correctly mentioned no driving ban, the order of a rehabilitation programme and/or the extension of the probationary licence as well as no MPA. When considering the 0.05% and the 0.11% BAC limit, around 50% of the subjects mentioned the correct extent of the driving ban. Because for the 0.11% BAC limit many subjects also expect a MPA (39.5%), the correct combination of both (driving ban and no MPA) drops to 27.4%. In the case of the 0.05% BAC limit, still almost 50% correct indications are found when additionally considering the MPA mentions. Almost no one expects it to be ordered when getting caught while driving with a BAC of above 0.05%. The fines are most often assessed to be lower than the correct ones. For all conditions (drugs; 0.00%, 0.05% and 0.11% BAC limit), the correct indications of fines amount to around 25% to 40%. The highest understatement can be found for the demerit points. Here, 60% to 70% of the subjects did not mention demerit points or assessed the number to be lower than the one that is actually imposed. Criminal proceedings are rather infrequently mentioned. But for drugs and the 0.11% BAC limit, it is expected more often (~30%) than for the conditions that definitely do not involve it (0.00% BAC limit, 0.05% BAC limit: ~10%).

It was tried to quantify the subjects' knowledge about legislation. A score was calculated for each subject, separated for drugs and alcohol, that expresses how good the subjects know the legal consequences. The score consists of the following points:

- one point for each correct mention of driving ban, fines, demerit points and criminal proceedings for the main BAC limits that apply for each person (young/novice drivers: 0.00%, 0.11%; experienced drivers: 0.05% and 0.11%) and for drug offences
- one point for each additionally mentioned BAC limit (0.00% for experienced drivers | 0.05% for young/novice drivers, 0.03%, 0.16%)

[80] Betäubungsmittelgesetz: Controlled Substances Act.

Table 96 shows how the alcohol- and drug-scores are put together. The drug-related knowledge-score can reach a maximum of four points. The alcohol-related knowledge-score can reach a maximum of eleven points.

Table 96: Score definition to describe the subjects' knowledge about the legal consequences for drug and alcohol offences.

		Driving ban	Fine	Demerit points	Criminal proceeding	Mentioning	Maximum score
Drug offence		1 point	1 point	1 point	1 point		**4 points**
Alcohol offence	0.00% | 0.05%	1 point	1 point	1 point	1 point		
	0.11%	1 point	1 point	1 point	1 point		
	0.05% | 0.00%					1 point	
	0.03%					1 point	
	0.16%					1 point	
							11 points

Figure 118 shows the percentage of subjects who reached the different score levels (left: drug score, right: alcohol score), separated for users and controls (in the case of drug offences) and young/novice and experienced drivers (in the case of alcohol offences). The overall distributions of the number of correct mentions of consequences for drug and alcohol offences are quite comparable. The greater part of the subjects reached less than half of the possible number of knowledge-points and few subjects knew nearly all consequences that have to be expected.

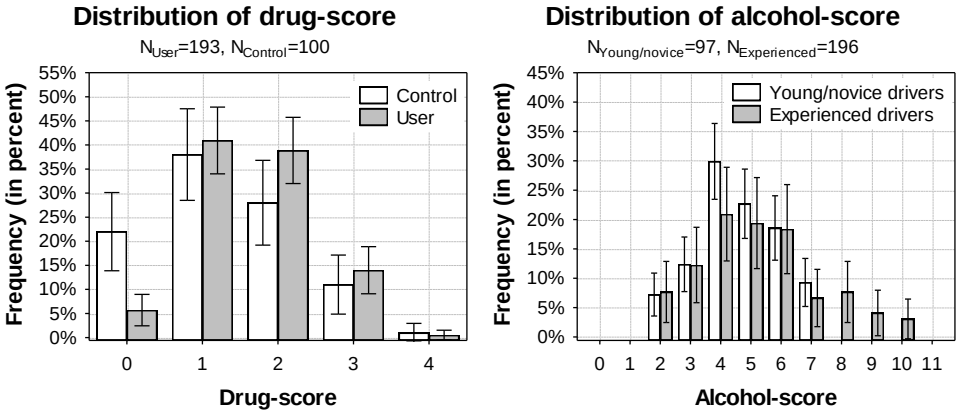


Figure 118: Distribution of drug- and alcohol-score for users and controls ($N_{Control}$=100, N_{User}=193) and young/novice and experienced drivers ($N_{Young/novice}$=97, $N_{Experienced}$=196) (in percent, ±0.95 CI).

While users had on average 1.6 points concerning their knowledge about the legal consequences of driving under the influence of illegal drugs, controls had with 1.3 points significantly less (t=2.95; p=0.003). Experienced drivers had on average 5.2 points concerning their alcohol-related knowledge of the legal consequences for driving under alcohol influence. Young/novice drivers had 4.6 points of eleven and therefore significantly less than experienced drivers (t=2.55; p=0.011). Users and controls did not differ in their knowledge about the consequences that were imposed when driving under the influence of alcohol.

14.16.3 Perceived stopping probability

The subjects' evaluation of the probability of being stopped while driving under influence, depending on time of the day and road type, was asked for in a questionnaire at the beginning of the study (Q-Start, Table 97).

Table 97: Q-Start question concerning risk of being stopped by the police.

Question
In the following question, you should estimate the risk of being stopped by the police on different routes at different times. Please assume that you are driving a five year old VW Golf without attracting attention. How likely do you think it is to get caught by the police on the following routes at the stated times (road section: city/city-suburb/suburb/rural, time: 6am-12pm/12pm-8pm/8pm-2am/2am-6am, weekday: weekday/weekend)? 1=very unlikely, 2=unlikely, 3=likely, 4=very likely → **Subjective risk of being stopped by police**

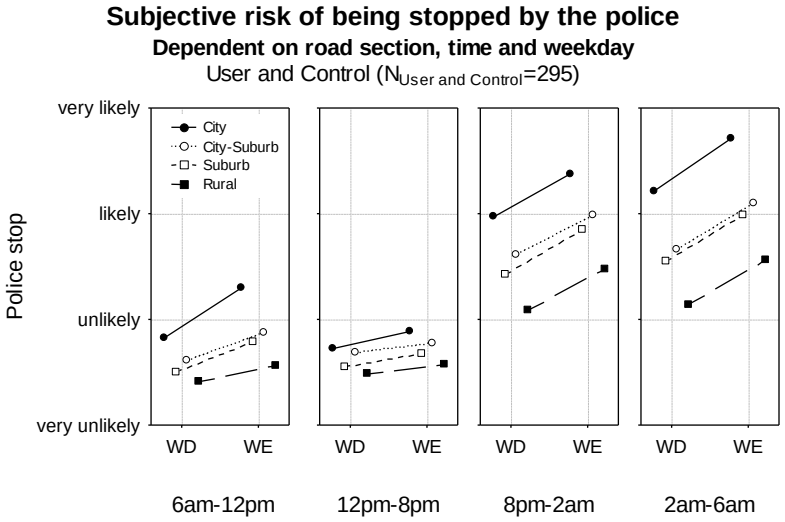


Figure 119: Subjective risk of being stopped (police stop very unlikely, unlikely, likely, very likely), depending on road section (city, city-suburb, suburb, rural), time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) and weekday (WD=weekday, WE=weekend) of users and controls ($N_{User\ and\ Control}$=295).

The subjective risk of being stopped by the police was graded higher on weekends than weekdays and higher at night (8pm-6am) than during the day (6am-8pm) (Figure 119). The road section had a clear effect with the highest grades for city roads. Here, the risk of being stopped in the morning hours (6am-12pm) was also rated relatively high, especially on weekends. The lowest ratings are found for rural areas.

The distribution of drives under influence resembles the distribution of the subjective risk of being stopped by the police shown in Figure 119 concerning *time* and *weekday* (Figure 120). The proportion of DUI of all drives was higher on weekends than weekdays and higher at night (8pm-6am) than during the day (6am-8pm). The *road section* had a clear effect also, but the effect was contrariwise to the subjective risk evaluations. Regardless of time and weekday, the percentage of DUI was always lower for city routes than for rural routes.

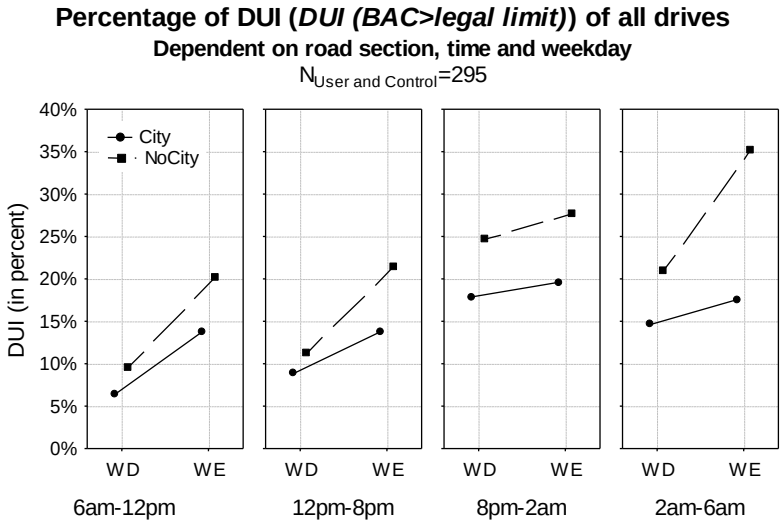


Figure 120: Percentage of DUI (DUI=under influence of any drug and/or BAC>legal limit), depending on road section (City: percentage of city roads 70% of route and more; NoCity: percentage of city roads less than 70% of route), time (6am-12pm, 12pm-8pm, 8pm-2am, 2am-6am) and weekday (WD=weekday, WE=weekend) of users and controls ($N_{User\ and\ Control}$=295).

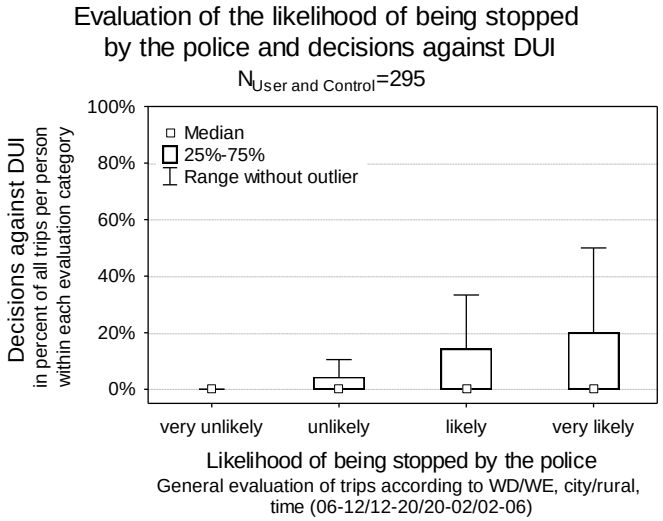


Figure 121: Percentage of decisions against DUI of all trips per person, depending to the subjective risk of being stopped by the police ($N_{User\ and\ Control}$=295).

To directly analyse how the subjective risk of being stopped by the police influences the decision to drive under influence, the percentage of trips that were travelled after having consciously avoided DUI (*consumption abdication*, *restricted consumption*, *drive abdication*; definition see Chapter 14.8) of all trips was examined with respect to the perceived risk of being stopped for the differnt routes at the differnt times

(Figure 121)[81]. The more likely the subjects think a police stop would occur, the more often they avoid driving under influence (KW-H (3;3,145)=56.34; p=0.000).

14.16.4 Perceived detection probability

The subjects' evaluation of the probability of being detected when being stopped by the police while driving under influence, depending on the substance under which the drive was travelled, was asked for in a questionnaire at the beginning of the study (Q-Start,Table 98).

Table 98: Q-Start question concerning detection risk.

Question
Someone drives under the influence of one of the following drugs (1 beer, more than 4 beers, cannabis, amphetamine, ecstasy, LSD/psilocybin, cocaine, opiates, sedatives) and gets into a police stop. Do the police notice in a roadside stop that the driver is under the influence of drugs? 0=influence definitely does not get detected by the police... 10=influence definitely gets detected → **Subjective detection risk**

The subjects do not believe that it is very likely that after drinking one beer or using sedatives or cannabis the police would notice in a roadside stop that the driver is under influence (Table 99; 0=influence definitely does not get detected by the police... 10=influence definitely gets detected). In contrast to users, control persons believe that the detection risk concerning cannabis is rather high. For drinking more than 4 beers or using any other substance (amphetamine, cocaine, ecstasy, LSD/psilocybin, opiates), the perceived detection risk increases and is the highest for LSD/psilocybin and opiates. Concerning stimulants (amphetamine, cocaine, ecstasy), controls grade the detection risk higher than users.

Table 99: Subjective detection risk for different substances of all subjects, of users (N_{User}=193) and controls ($N_{Control}$=100) (0=influence definitely does not get detected…10=influence definitely gets detected).

	MD All	MD Control	MD User	Z	p-level	$N_{Control}$	N_{User}
1 beer	2	2	2	1.10	0.273	99	193
Sedatives	5	6	5	1.73	0.084	100	193
Cannabis	5	7	5	4.27	**0.000**	100	193
More than 4 beers	7	7	8	-0.13	0.900	100	193
Amphetamine	7	8	7	4.22	**0.000**	100	193
Cocaine	7	8	7	4.48	**0.000**	100	193
Ecstasy	8	9	8	2.25	**0.024**	100	193
LSD/psilocybin	9	9	9	-0.65	0.513	100	193
Opiates	9	9	9	-0.18	0.860	100	193

The perceived detection risk had no influence on the number of drives under influence of illegal drugs and/or alcohol above the legal limit within 30 days. An effect was found for gender with regards to the perceived detection risk when drinking 1 beer, more than 4 beers or sedatives. Males believe that it is more likely to be

[81] Therefore, the individual evaluations of the risk of being stopped by the police were allocated to each trip according to weekday, route and time.

detected when being stopped by the police after consuming alcohol than females believe (1 beer: MWU: Z(1;292)=3.75; p=0.000; more than 4 beers: MWU: Z(1;293)=4.59; p=0.000). Females believe that it is more likely to be detected when being stopped by the police after consuming sedatives (MWU: Z(1;292)=2.12; p=0.034). Moreover, 18-24-year-olds think that it is more likely to be detected after the consumption of stimulants than 30-39-year-olds (MWU: Z(1;147)=3.24; p=0.001). If effects concerning the residence reached significance, they indicated that people from rural and city areas perceived the detection risk as less likely as compared to subjects from urban areas (i.e. the detection of amphetamine, ecstasy, LSD/psilocybin) (amphetamine-rural-urban: MWU: Z(1;219)=2.35; p=0.019; ecstasy-rural-urban: MWU: Z(1;219)=2.15; p=0.032; ecstasy-city-urban: MWU: Z(1;179)=2.71; p=0.007; LSD/psilocybin-rural-urban: MWU: Z(1;219)=2.72; p=0.007; LSD/psilocybin-city-urban: MWU: Z(1;179)=2.07; p=0.038).

14.16.5 Road traffic regulations

In Germany, there are two BAC limits for the operation of a vehicle that are found in the German Road Traffic Act (StVG):

- **Zero-tolerance (0.00%)** for novice drivers, all drivers between the ages of 18 and 21 years and newly licensed drivers of any age for the first two years of having a licence,
- **0.05%** for all other drivers.

To make assumptions about the potential influence of current road traffic regulations on the occurrence of drug driving, the 18-24-year-old sample was analysed regarding the influence of the current legal BAC on the following parameters:

- percentage of BAC-positive drives of all drives,
- total alcohol dose that was consumed within the study period, and
- total number of episodes with alcohol consumption within the study

Table 100 shows the number of subjects within the study sample for which the two BAC-levels were valid, separated according to their assignment to study group and age group.

Table 100: Sample size for legal alcohol limits, depending on study group and age group (N=295).

		Legal BAC limit		
Study group	**Age group**	**0.05%**	**0.00%**	**Total**
User	**18-24**	50	67	
	25-29	49	1	
	30-39	27	1	
	Total	126	69	195
Control	**18-24**	27	28	
	25-29	26	0	
	30-39	19	0	
	Total	72	28	100

Since the data distribution of the analysed variables was not normal, rank order tests were applied (Mann-Whitney U-test). While the current legal BAC limit (BACLimit: 0.00% vs. 0.05%) had no influence on the total alcohol dose and the total number of alcohol consuming episodes within the study period, the percentage of BAC-positive drives of all drives was higher for those 18-24-year-olds for whom the legal BAC limit was 0.05% compared to those for whom the legal BAC limit was 0.00% (MWU: Z(1;172)=2.10; p=0.036).

Furthermore, it was analysed if the study group (users vs. controls), gender (male vs. female) or residence (rural vs. urban vs. city) have an influence on the proportion of BAC-positive drives beyond the legal BAC limit (by Kruskal Wallis H-Tests and Mann-Whitney U-tests). A significant result was found for study group (MWU: Z(1;172)=4.14; p=0.000). Possible interactions were analysed according to the testing procedure explained in Chapter 14.5.2. Because of the positive interaction that was found for Gender*BACLimit (L(1;171)=4.64; p=0.031) and an interaction by trend for Study group*BACLimit (L(1;171)=3.85; p=0.050), the analysis was conducted for the different levels of each factor.

When the 0.05% limit is considered, users and controls do not differ in their proportion of BAC-positive drives, whereas they do when the 0.00% limit applies (MWU: Z(1;95)=4.43; p=0.000) (Figure 122, left). This results from a significant decrease in BAC-positive drives in the control group (MWU: Z(1;55)=3.86; p=0.000). The users did not drive less often under the influence of alcohol when the 0.00% limit applies compared to when the 0.05% level applies. Males have more BAC-positive drives than females when the 0.05% limit applies (MWU: Z(1;77)=2.20; p=0.028). No difference is found when the 0.00% limit applies (Figure 122, right). Males drove less often with a positive BAC when the 0.00% limit applies compared to when the 0.05% limit applies (MWU: Z(1;113)=3.23; p=0.001), whereas the proportion of positive BAC drives is low in both conditions for females.

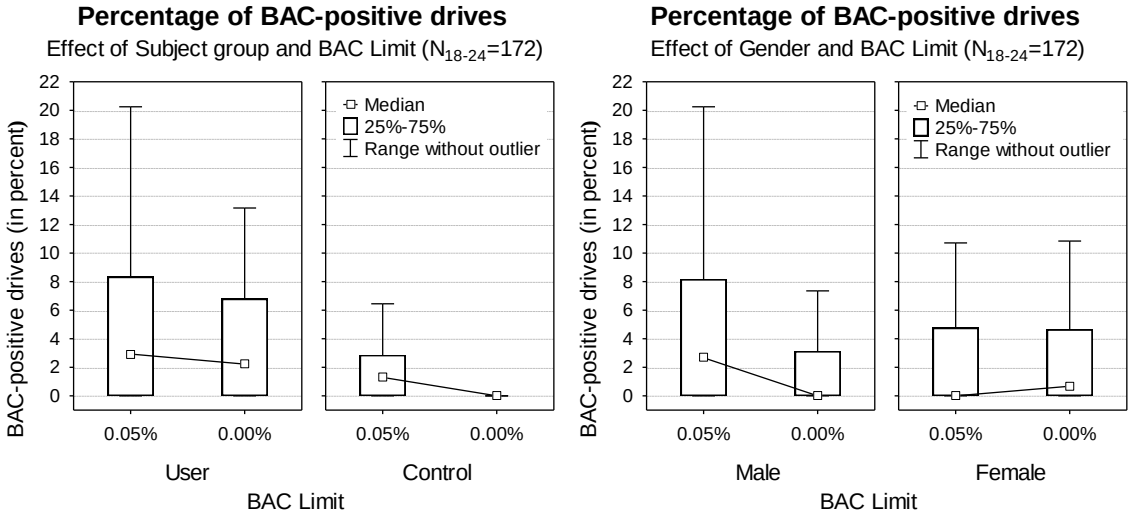


*Figure 122: Effect of Subject group*BAC Limit and Gender*BAC Limit on percentage of BAC-positive drives of all drives of the 18-24-year-old sample (N_{18-24}=172) (Median, 25%-75%, Range without outlier).*

The results show that the legal BAC limit has an effect on the occurrence of BAC-positive drives but not for each considered group of subjects. Control persons and males reduce their BAC-positive drives according to the applied legal BAC, whereas females and drug users do not. The former have a low number of drives under influence anyway, the latter often drive under influence, independent of the height of the legal BAC limit.

14.16.6 Expected degree of sanction and subjective sanction severity

To analyse if sanctions have an effect on the frequency of DUI, not the correctness of the stated sanctions were consulted but the expected degree and the subjective sanction severity (corresponding question: see Table 93 in Chapter 14.16.2). At first, every mentioned sanction was quantified by summing up sanction-points. The higher the stated sanction was (driving ban, fine, demerit points), the more points were allocated. If the participation in a rehabilitation programme and/or the extension of the probationary licence, subsequent criminal proceedings or a MPA were mentioned, additional points were allocated. The allocation of the sanction-points, based on the kind and the quantity of sanctions, is shown in Table 101.

Table 101: Sanction-points to quantify the expected degree of sanction.

Sanction-points due to kind and quantity of sanction			
Driving ban	**Fine**	**Demerit points**	**Others**
0 months = 0 1-2 months = 1 3-5 months = 2 ≥6 months = 3	0 € = 0 ≤250 € = 1 ≤750 € = 2 >750 = 3	0 points = 0 1-2 points = 1 3-4 points = 2 ≥5 points = 3	Reh/Prob=1 Criminal proceeding=2 MPA=2

Table 102 shows the true degree of sanction (*true sanction*) for drug offences and the main alcohol offences (0.00%, 0.05%, 0.11%) that would be reached if the correct sanction was mentioned. For drug driving and driving with a BAC of 0.11% and higher, the true degree of sanction is highest (sanction-score=11). For the violation of the 0.00% BAC limit, the true degree of sanction is lowest (sanction-score=3). For the violation of the 0.05% BAC limit, the true degree of sanction is a little higher than the one for violations against the 0.00% BAC limit and quite lower than the one for drug offences and BAC 0.11% violations (sanction-score=5).

Table 102: True degree of sanction (sanction-score) for the different offences.

	Driving ban	**Fine**	**Demerit points**	**Reh/Prob**	**Criminal proceed.**	**MPA**	**SUM**
drugs	3	2	2	0	2	2	11
BAC 0.00%	0	1	1	1	0	0	3
BAC 0.05%	1	2	2	0	0	0	5
BAC 0.11%	3	3	3	0	2	0	11

Figure 123 shows the expected degree of sanction (*expected sanction*) contrasted with the true degree of sanction (*true sanction*) for the different offences. For drug offences and violations of the 0.11% BAC limit, the expected degree of sanction that was assessed by the subjects was lower than the true degree of sanction. The expected degree of sanction for violations against the 0.00% and 0.05% BAC limit

were quite in line with the true degree of sanction. The highest expected degree of sanction was found for driving with a BAC of 0.11% or higher[82]. The lowest was found for driving with a BAC above the 0.00% and 0.05% BAC limit.

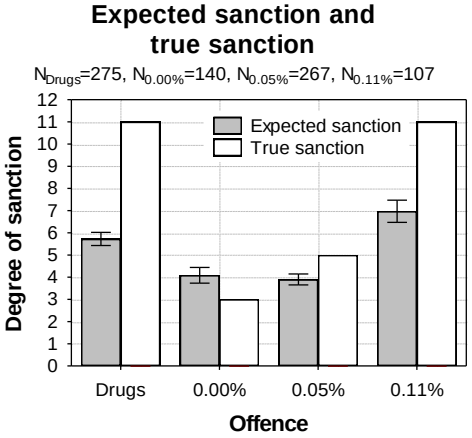


Figure 123: Expected degree of sanction and true degree of sanction, calculated according to the mentioned sanctions and true sanctions that are imposed for the different offences (drugs, BAC>0.00%, BAC≥0.05%, BAC≥0.11%; Mean, ±0.95 CI; Number of cases see in figure).

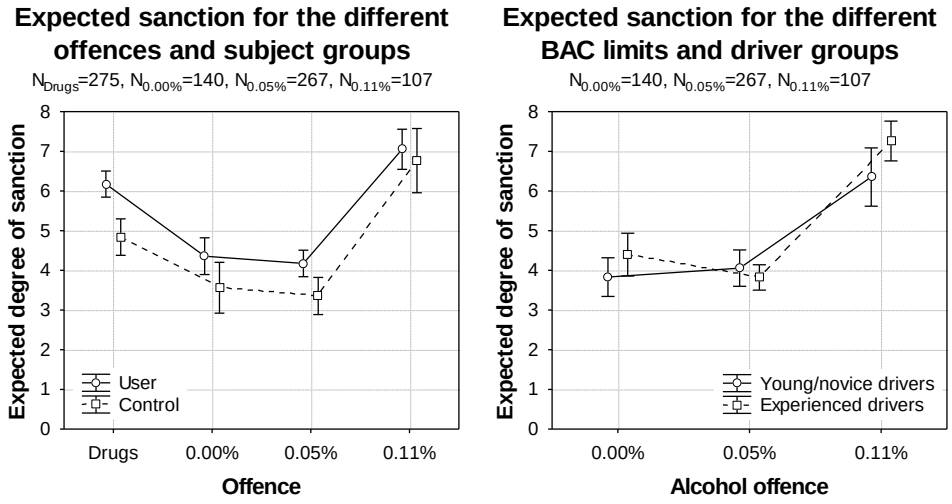


Figure 124: Expected degree of sanction for the different offences (drugs, BAC>0.00%, BAC≥0.05%, BAC≥0.11%; Mean, ±0.95 CI), depending on subject group (user, control; left) and driver group (young/novice driver, experienced driver; right) (Number of cases see figure).

Except for the sanctions for violations of the 0.11% BAC limit, the users in general assessed the sanction to be higher than the controls (Figure 124, left)[83]. Between young/novice and experienced drivers no different assessment of the degree of sanction concerning alcohol offences was found (Figure 124, right).

[82] $t_{0.11\%\text{-drugs}}=4.32$; $p=0.000$ | $t_{0.11\%\text{-}0.00\%}=9.61$; $p=0.000$ | $t_{0.11\%\text{-}0.05\%}=12.13$; $p=0.000$ | $t_{\text{drugs-}0.00\%}=6.63$; $p=0.000$ | $t_{\text{drugs-}0.05\%}=9.29$; $p=0.000$.

[83] $t_{\text{Drugs}}=4.32$; $p=0.000$ | $t_{0.00\%}=2.15$; $p=0.034$ | $t_{0.05\%}=3.16$; $p=0.002$.

The expected degree of sanction was contrasted with the subjective sanction severity (corresponding question: see Table 93 in Chapter 14.16.2) because the latter one has most likely an effect on driving under influence. Figure 125 shows that the relative course of the expected degree of sanction and the subjective sanction severity for the different offences is quite comparable. So, the higher the expected degree of a sanction, the higher the subjective sanction severity is.

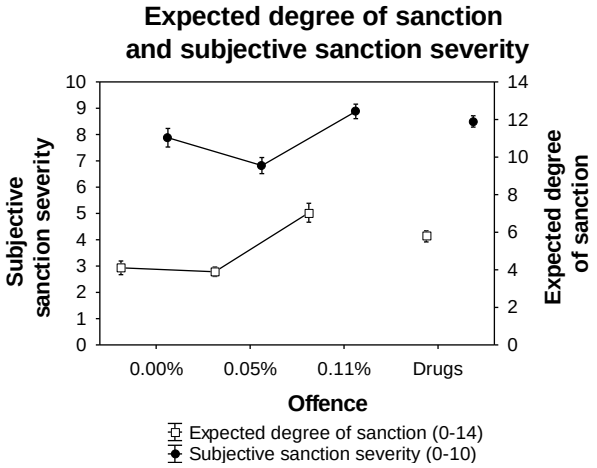


Figure 125: Expected degree of sanction and subjective sanction severity for the different offences (0.00%, 0.05%, 0.11%, drugs; Mean ±0.95 CI; N for expected degree of sanction see Figure 123; for subjective sanction severity: $N_{0.00\%}$=143, $N_{0.05\%}$=279, $N_{0.11\%}$=108, N_{Drugs}=287).

Figure 126 shows the effect of the subjective sanction severity on the frequency of drives under influence. For this illustration, the subjective sanction severity was classified into a high sanction severity and a low sanction severity (by median-split).

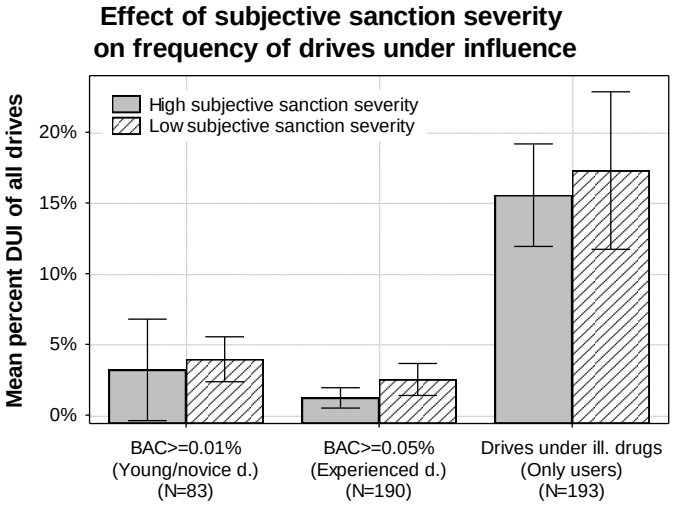


Figure 126: Effect of subjective sanction severity on the percentage of drives under influence ($N_{Young/novice\ drivers}$=83, $N_{Experienced\ drivers}$=190, N_{Users}=193; Mean, ±0.95 CI).

The experienced drivers tend to drive more often above the legal BAC limit when the subjective sanction severity was low compared to when it was high. But this effect did

not reach significance (t=1.44, p=0.153). The results for young/novice drivers when considering their mean percentage of drives above the legal BAC limit and for users when considering their mean percentage of drives under the influence of illegal drugs go in the same direction but are far from reaching significance.

CONCLUSION

15.Integration of the results

In the following, all results from the study that are relevant for prevention and rehabilitation purposes are integrated by referring to a qualitative model that was developed by Hargutt (cited in Krisman & Schöch, 2011: Draft of a model-tool, Section 9.2) within the framework of the DRUID project (Figure 127). The model depicts dependencies of different societal, behavioural and legal variables that are relevant to combat driving under influence.

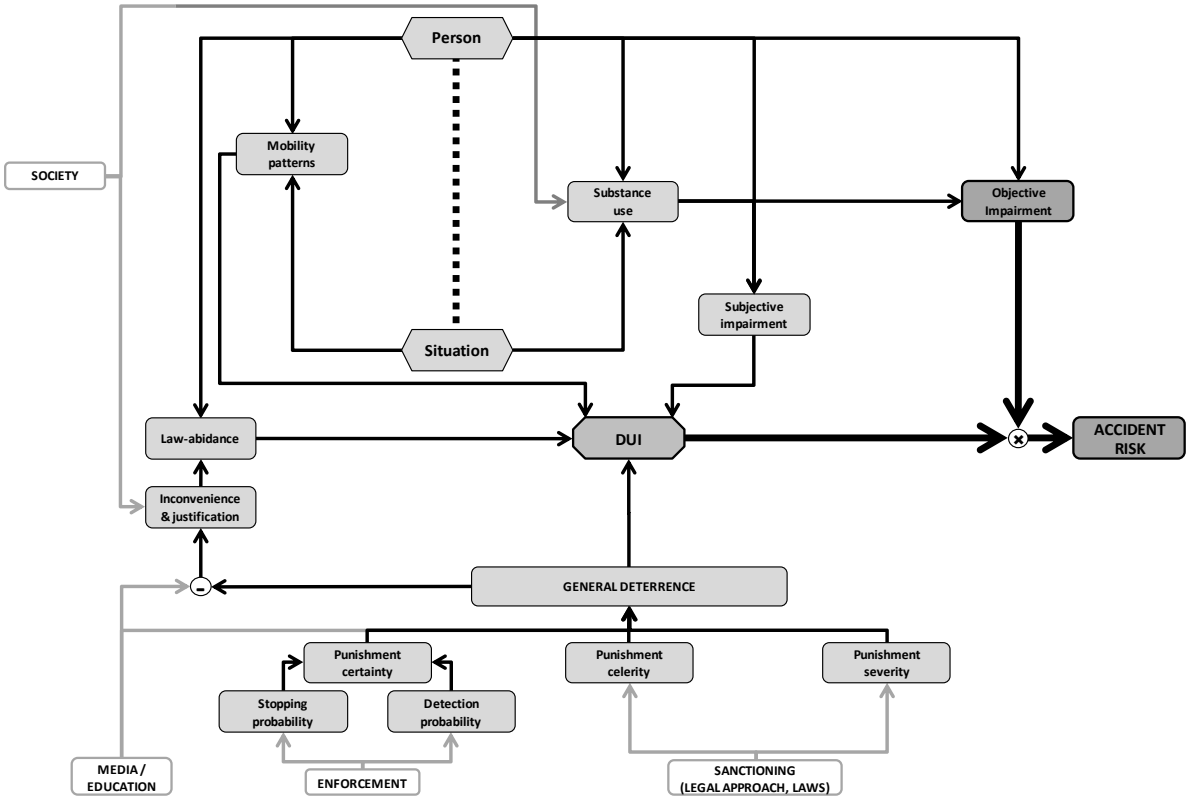


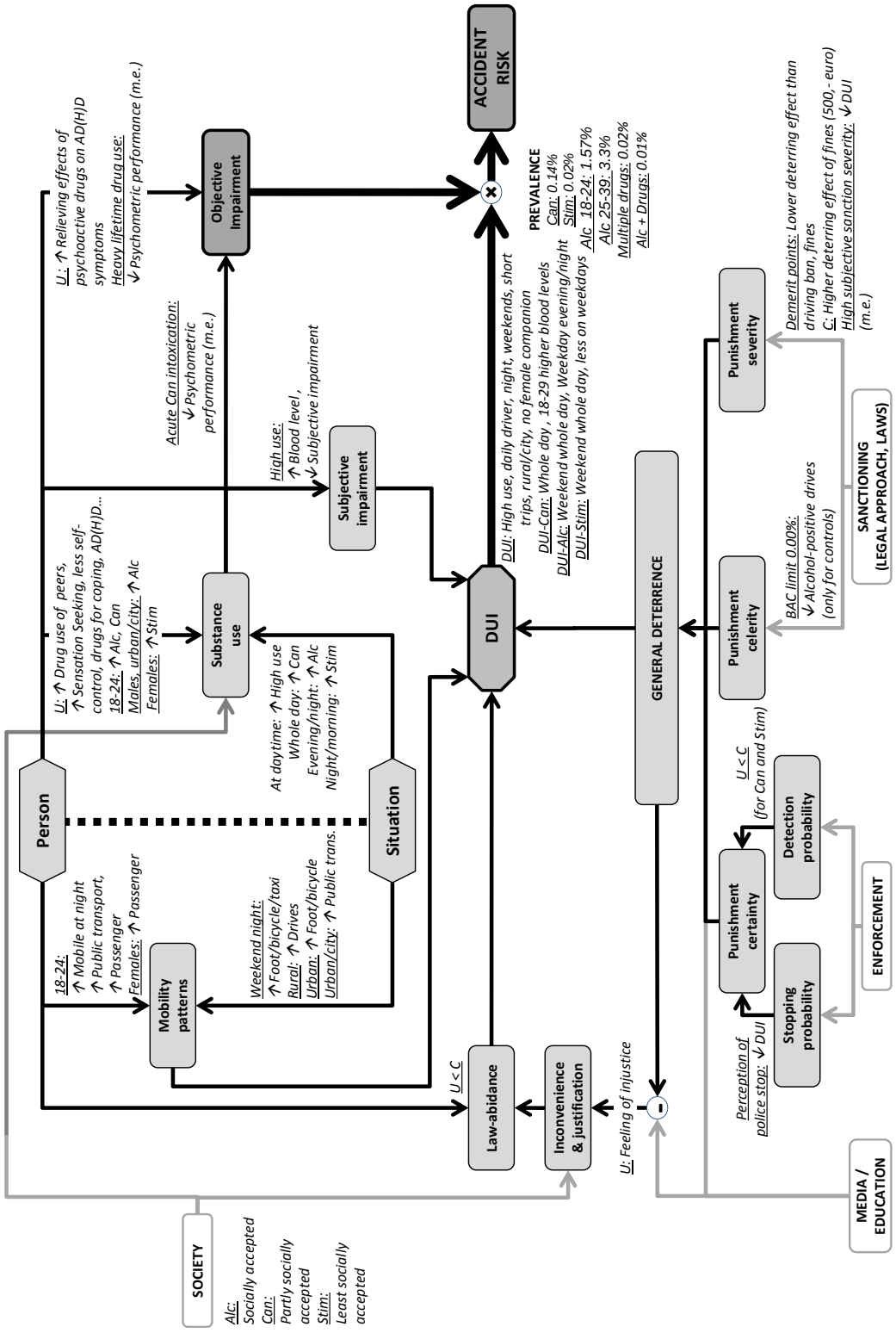
Figure 127: Model that contains different societal, behavioural and legal variables that are relevant in the context of developing measures to combat DUI.

In the following, a short description of the variables is given:

- **SOCIETY:**
  - Demographic structure, mindset, toleration, availability of drugs, etc..
- **MEDIA/EDUCATION** (press/media activities about sanctioning and enforcement strategies):
  - Creates awareness/acceptance and enhances general deterrence effect

- **GENERAL DETERRENCE**: Punishment certainty, punishment celerity, punishment severity, media/education
  - **PUNISHMENT CERTAINTY** (enforcement):
    - **STOPPING PROBABILITY**: dependent on officer training, time and location of control sites
    - **DETECTION PROBABILITY**: dependent on screening devices
  - **PUNISHMENT CELERITY** (legal approach regarding sanctioning): Immediacy and efficiency of sanctioning (impairment approach leads to slow juridical procedures due to obligatory court trials, whereas per se laws and zero-tolerance leads to rather quick administrative procedures where court trials are not mandatory)
  - **PUNISHMENT SEVERITY** (laws regarding sanctioning): Severity, consistency, transparency of sanctions
- **INCONVENIENCE and JUSTIFICATION**: dependent on *society*, *general deterrence*, *media/education*
  - Describes the limit of what a society (dependent on the mindset) will endure (e.g. control measures, surveillance)
  - The negative nexus between *general deterrence* and *media/education* means that the effect of high deterrence on inconvenience can be lowered by media campaigns that explain and justify enforcement/sanctioning
- **PERSON**: Personality, sociodemographic characteristics, diseases, social background of a person, etc..
- **SITUATION**: Time, day of the week, companions, residence, etc..
- **SUBSTANCE USE**: dependent on *person* (e.g. personality), *situation* (e.g. weekend night) and *society* (e.g. alcohol use socially accepted)
- **MOBILITY PATTERNS**: dependent on *person* (e.g. young persons are more mobile at night), *situation* (e.g. no availability of public transport at night)
- **SUBJECTIVE IMPAIRMENT**: dependent on *substance use* (e.g. dose) and *person* (e.g. addicts)
- **OBJECTIVE IMPAIRMENT**: dependent on *substance use* (e.g. dose) and *person* (e.g. relieving effects of psychoactive drugs in the case of AD(H)D, other diseases)
- **LAW-ABIDANCE**: dependent on *inconvenience and justification* (e.g. high risk awareness through media efforts) and *person* (e.g. personality, addicts/patients)
- **DECISION DUI**: dependent on *subjective impairment* (e.g. low in the case of heavy users, high in the case of moderate users), *mobility patterns* (e.g. public transport available/not available), *law-abidance* (e.g. low/high risk awareness regarding the punished behaviour) and the *general deterrent effect* (e.g. low/high perceived stopping probability)
- **ACCIDENT RISK**: dependent on the occurrence of DUI and the *objective impairment* (multiplicative nexus: a high objective impairment is rather unproblematic when the occurrence of DUI in traffic is low and a high occurrence of DUI is rather unproblematic when the objective impairment is low)

Figure 128 shows the main results assigned to the single variables of the model.



U=user; C=control; Alc=alcohol; Can=cannabis; Stim=stimulants (amphetamine, ecstasy, cocaine); Alc+Drugs=alcohol+cannabis/stimulants/cannabis+stimulants, Multiple drugs=alc+drugs, cannabis+stimulants, cannabis+heroin; m.e.=marginal effect.

Figure 128: Model that contains different societal, behavioural and legal variables that are relevant in the context of developing measures to combat DUI and the corresponding results of the present study.

In the following, a detailed description of the results per single variable of the model is given:

- **Prevalence** of **DUI**
  - Alcohol: 1.57% for 18-24-year-olds, 3.3% for 25-39-year-olds (drug combinations included)
  - Drugs: 0.14% for cannabis (drug combinations included), 0.02% for stimulants (drug combinations included), 0.02% for multiple drugs, 0.01% for drugs in combination with alcohol
- Influence of **society** on **inconvenience and justification/substance use**
  - Alcohol use is socially accepted: 98% of the controls state that they do not abstain from drinking alcohol
  - Of all illegal drugs, cannabis is the most accepted among controls (47%), so-called “hard” drugs are scarcely accepted (8%-15%)
- Deterrence effect of **stopping probability**
  - The more probable a person thinks a police stop could occur, the more often the person decides against DUI
  - Apart from characteristics of drug intake, the decision to drive under influence is stated to depend to a great extent on the density of police controls
- Deterrence effect of **detection probability**
  - Users grade the detection probability of drives under the influence of cannabis and stimulants (the main categories of DUI within the present study) lower than controls; with respect to other substances, no differences were found
- Deterrence effect of **punishment celerity**
  - In Germany, for young and novice drivers[84] the impairment approach for alcohol-positive drives with low BACs was exchanged by a zero-tolerance approach in 2007. So, for young and novice drivers a higher punishment celerity concerning low BACs can be assumed. It was shown that controls for whom the zero-tolerance for alcohol applies drive less often under the influence of alcohol than controls for whom the 0.05% BAC limit applies; for users no effect was found[85]
- Deterrence effect of **punishment severity**
  - Demerit points seem to have a lower deterring effect compared to driving bans and fines
  - Most users who committed no or only some drives under influence stated that a penalty of up to 500 euros would deter them from DUI, whereas users who committed many drives under influence often said that they would only be deterred from DUI when the penalty was 1,000 euros and higher

[84] All drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence.

[85] The interpretation of this result should be seen with reservations. Narrowly defined, it actually involves the comparison of different legal approaches for the same offence that differ in immediacy of the sanctioning process when studying the deterrence effect of punishment celerity (e.g. a slow juridical procedure versus a quick administrative procedure in the case of violations against the zero-tolerance for alcohol). In the present case, a law for young and novice drivers was introduced for the purpose of combating a behaviour (drives with a BAC≥0.02% and <0.05%) that is - for the rest of drivers - not an offence in general (only in the case of a BAC≥0.03% and signs of impairment/endangerment/the occurrence of an accident; all legal binding consequences for driving under influence in Germany can be seen in Chapter 14.16.1).

  - Only a small effect was found in terms of subjective sanction severity. The more severe a sanction is evaluated, the less often the person drives under influence
- Influence of **inconvenience and justification** on **law-abidance** (developed from societal influences and legal regulations)
  - Users have a more liberal attitude towards DUI compared to controls
  - According to users, driving under the influence of cannabis and stimulants is less condemnable than according to controls
  - Controls for whom the 0.00% BAC limit applies take driving with low BACs as more condemnable as controls for whom the 0.05% BAC limit applies (all aged 18-24)
  - Cannabis users have a feeling of injustice compared to persons who drink and drive because of the long traceability of the substance in body fluids and because of different legal approaches for drink and drug driving
- Influence of **person** on **substance intake**
  - *Sociodemographic variables*: Male drug users more often use alcohol and cannabis compared to female drug users, female drug users more often use stimulants compared to male drug users, younger drug users more often use drugs compared to older drug users, users from urban and city areas drink more alcohol, whereas users from rural areas use more cannabis
  - *Personality* (pronounced characteristics of users compared to controls): Sensation seeking, symptoms of hyperactivity/impulsivity in childhood, negative psychological and social after-effects due to AD(H)D symptoms, use of psychoactive substances as coping strategy, openness to new experiences and motivation in response to cues for reward, external locus of control, less conscientiousness, awareness of fallibility with regards to own driving behaviour
  - *Mental diseases* (pronounced characteristics of users compared to controls): Drug Dependence and Abuse Disorders, Mental diseases (especially Mood Disorder, i.e. Major Depression with Recurrent Episodes and Bipolar Disorders, AD(H)D and Borderline Personality Disorder)
  - Excessive users report more clinically impairment or distress due to drug use and a higher intention to change/stop substance consumption compared to heavy and moderate users
  - Users and those who often drug drive report that substance use and drug driving, respectively, is quite common in their social environment (family, peers)
  - Users report lower attachment to parents and lower parental monitoring which is said to spawn a tendency to behave delinquently, in the present case to use drugs
- Influence of **situation** on **substance intake**
  - Higher consumption on weekends than on weekdays and at nights compared to at daytime, cannabis is consumed rather all day long, alcohol mainly in the evening/at night, stimulants especially late at night/in the early morning
  - Excessive and to some part heavy users use drugs all day long and independent from the day of the week, whereas moderate users restrict consumption to evenings/nights and weekends
- Influence of **person** on **mobility pattern**
  - 18-24-year-olds more often use other modes of transport instead of driving and are more mobile at night

- Influence of **situation** on **mobility pattern**
  - Subjects from urban and city areas especially use public transport instead of driving, subjects from urban areas also more often walk or use a bicycle, subjects from rural areas drive more often, on weekend nights the proportion of trips by foot, bicycle or taxi is higher than at any other time of the week
- Influence of **person/substance intake** on **subjective impairment**
  - For moderate and heavy users, a dose-dependent subjective impairment was found
  - For excessive users, no dose-dependent subjective impairment was found; even if they have higher substance blood levels while driving compared to moderate and heavy users, they do not report a higher subjective impairment
  - Excessive users more often developed a tolerance to the substance they are using
  - Heavy and excessive alcohol users compared to moderate users take the view that they can drink higher amounts of alcohol and still have the ability to drive safely
- Influence of **substance intake** on **objective impairment**
  - Acutely cannabis intoxicated users show a marginally lower psychometric performance than those who were not acutely intoxicated
- Influence of **person** on **objective impairment**
  - Users compared to controls report more relieving effects of psychoactive substances on AD(H)D symptoms
  - Heavy lifetime drug users (users of so-called “soft” and “hard” drugs) compared to controls and light drug users (users of esp. so-called “soft” drugs) show a marginally lower psychometric performance
- Influence of **person** on **law-abidance**
  - Users have a lower willingness to law-abidance than controls
- Influence of **substance use/subjective impairment** on **DUI decision**
  - The more one consumes, the more DUI one commits and the higher the level of intoxication while driving is
  - The decision to drive under influence is stated to mainly depend on characteristics of drug intake (amount, type and effect of consumed drug, time of drug consumption), especially the time between drug consumption and driving
  - If subjects are to decide upon consumption or driving, excessive users less often decide against drug driving, whereas heavy and moderate users often refrain from driving, moderate users additionally relatively often refrain from consumption or restrict their consumption because of a drive
- Influence of **mobility patterns** on **DUI decision**
  - DUI is more common in the evening/at night and on weekends, although the proportion of refraining from driving or drug use to avoid drug driving is highest at that time, too
  - Drives under the influence of cannabis are committed quite often at any time of the day, on weekdays especially in the evening, on weekends also late at night; drives under the influence of alcohol most often occur in the evening/at night, on weekends additionally in the morning/afternoon due to residual effects from drinking the day before; drives under the influence of stimulants most often

occur on weekends, mostly in the evening/at night, but also quite often in the morning/afternoon

- DUI is more common on short trips than trips that cover longer distances, even though subjects often refrain from driving on short trips; on longer trips, the proportion of refraining from consumption because of the drive is highest
- DUI is least frequent in urban areas compared to rural and city areas where the possibility of using public transport is rather low at times when DUI is most common and the distances that had to be covered are rather far
- If female companions are present, the proportion of DUI is lowest; if a male and a female person accompany each other, males more often decide against and females more often decide towards DUI
- Decisions against DUI differ depending on the general frequency of driving: subjects who generally drive less frequently more often consume as usual and refrain from driving because of previous consumption, whereas more regular drivers more often restrict their consumption because of the necessity to drive
- Apart from characteristics of drug intake and the density of police controls, the decision to drive under influence is stated to depend to a great extent on whether or not passengers could be endangered and if there exists a possible option to ride along with another person

16.Discussion

16.1 Study aim and methodological approach

Whereas national and international data about drug use and driving exist separately (for Germany MiD, ESA), data about driving in combination with information about drug use have not been available yet. In general, roadside surveys are conducted to collect valid information about the prevalence of drug driving within a population. In Germany, the only survey of this kind was conducted more than 15 years ago in 1994 (Krüger et al., 1996). Besides amendments to traffic regulations for drink and drug driving, the mobility rate, youth culture and demographic trends have changed in recent years. Therefore, the validity of those data for the current situation in Germany is very limited.

The present study (GSS 2007-2009) tried to fill this gap of information by implementing a new study approach. Instead of detecting drugs in the driving population – like roadside surveys do – 195 regular drug users (mainly cannabis users)[86] and 100 control persons (no use of illicit drugs, alcohol consumption allowed) who regularly drive a motor vehicle were queried for four weeks about their driving and drug consumption[87] behaviour by a questionnaire deployed on smartphones. Through the synchronization of consumption and driving data, it was possible to identify the occurrence of drug driving incidences of each subject over a 4-week time period. The daily reports covered individual drug use and driving behaviour in a broader context. Conditions like time of day, companions and reasons for driving and not driving were recorded as well. An extended diagnostic part was also included in the study to gather relevant person-related information in order to gain insight into driver or – more specifically – drugged driver characteristics.

The questionnaire application on the smartphones was achieved by developing a smartphone application programme using the BlackBerry graphical user interface and network access. The questionnaire was deployed on smartphones. So, the subjects could operate it wherever and whenever they wanted to. They had to send each report at the latest two days after the recorded day. This procedure made data collection very convenient. In the case of logical errors within the data, a system-controlled error-feedback was triggered by the smartphones. The subjects had to correct the error before they could continue and before they could send the report. Not all data inconsistencies were detectable by system-controlled consistency checks. So, much effort had to be spent on controlling the data, calling the subjects in the case of inconsistencies and correcting false statements. For this purpose, a control form was designed in Microsoft Access, which was accessible from all

[86] Originally 200 users, 5 were excluded from all analyses because they did not use cannabis within the study period.
[87] Use of illegal drugs, alcohol, abuse of psychoactive prescription medicines.

workstations at the study centre. Therein, the reports were listed and clearly arranged per subject in chronological order. Thus, the investigators could scroll through the individual days, refer to previous reports and easily detect inconsistencies. The questionnaire was very complex. The subjects had to list every situation and intermediate trip in chronological order with special emphasis on situations in which they used drugs and trips that were travelled as driver of a vehicle. If the questionnaire was less complex, the frequency of data inconsistencies should decrease or could probably even entirely be averted by system-controlled error-feedback. The system itself was reliable in terms of the technical setup. The database server's internet connection, and thus the connection to the smartphones, was rarely lost. The server's main board broke once during the study. However, since a copy of the server's hard disk had been created, no data were lost.

The compliance was very good. 328 subjects were initially included in the survey. Nine cancelled the participation because of personal reasons. Another 19 were excluded because their driving and drug use occurred too infrequently within the 4-week study period. All but 13% of the remaining 300 subjects provided complete data sets (i.e. at least 28 daily reports). The good compliance rate can mainly be attributed to the staggered financial reward system that was applied. The subjects did not get a fixed amount of money for taking part in the study but rather could earn credits for every single effort that they had carried out over the whole study period. The total amount of credits was paid in cash in the end. The study design does not allow for a non-responder analysis because nothing is known about the characteristics of the users who did not take part in the study. Nevertheless, the good agreement between the survey data and the representative data about driving and drug use in Germany (MiD 2008, ESA 2006) support the conclusion that those who did not take part and those who were participating do not differ much concerning the relevant variables. To inspire confidence in the study, assuring the protection of data privacy and providing a transparent picture of the study in public were very important issues. For this purpose, a web-site was created (www.doyoudrugdrive.de) on which interested persons could find detailed information about the study and a special section about every provision that had been taken and maintained concerning the anonymous data recording. To validate the reported data about drug use, a urine sample had to be delivered without previous announcement once within the study period. The agreement between the results from the toxicological analysis and the data about previous drug use from the daily reports was very satisfying.

Through the longitudinal observation of drug use and driving behaviour of single persons, it was possible to identify driving, consumption and drug driving patterns and to connect high risk behavioural patterns with situational and person-related influencing factors. So, a database for quantifying the drug driving prevalence as well as for analysing surrounding conditions was created.

16.2 Study results

The primary aim of the survey was to estimate the prevalence of drug driving in Germany. The main prerequisite to extrapolate the results of the survey into representative values is that the study sample represents the general population with regards to all crucial characteristics. To account for this, well-defined selection criteria (age 18-39, regular driving and regular drug use vs. no drug use for the control group) were applied to include only those subjects who are at risk of driving under influence in the first place. Furthermore, the sample was stratified according to the variables gender, age (18-24, 25-29, 30-39) and residence (rural, urban, city areas), which are known to serve as confounders for driving and drug use, respectively. Through a very effective and widespread recruitment strategy (media relations, flyer, web-site, word-of-mouth-recommendation), a final sample that was comparable with the corresponding proportions of the population of interest on all relevant variables was achieved and a good agreement between driving and drug use data of the sample and the data from national surveys (MiD 2008, ESA 2006) could be demonstrated.

To decide on whether a drive was conducted under the influence of illicit drugs or alcohol, BACs (according to Widmark formula; Widmark, 1932) and THC blood plasma concentrations (according to THC elimination curve by Sticht; G. Sticht, personal communication, December 2009) were calculated for each drive by using the reported information about the dose of cannabis and alcohol that was consumed previous to a drive, respectively, and by taking into account the time lag between consumption and driving. A drive was classified as substance-positive drive if the calculated BAC was 0.01% or higher and/or the calculated THC blood plasma concentration was 1ng/ml or higher. For the remaining substances, the doubled half-life of each substance was applied (provided by Schulz & Schmoldt, 2003; Passie et al., 2002; Prisinzano, 2005): Drives within the doubled half life time after consumption were classified as drug-positive. For the interpretation of the following numbers, it should be kept in mind that regular drug users were queried within the present study who consume drugs rather often (at least once a week; median consumption days per week: 5 days) and drive on a regular basis (at least on 1-2 days a week). This sub-population does not even account for 1% of the traffic volume on German streets. The relatively high frequency of drug driving that was found within the user sample diminishes as soon as it is extrapolated into representative prevalences of the general driving population.

Prevalence of psychoactive substances within the German driver population

How often does DUI occur within the study sample?[88]

Averaged per person, 20.5% of the users' drives were under the influence of drugs. The most prevalent drug that was found while driving was cannabis. The mean

[88] In the following, all questions that were lined out in Chapter 14.3 to show the main points of the data analysis, which were provided by the survey, are listed to structure the summary of the results.

percentage of drives under the influence of cannabis alone was 13.1% (total, i.e. drug combinations included: 14.8%). On average, 4.1% of the users' drives were under the influence of alcohol (total: 5.4%) and 1.5% under the influence of stimulants[89] (total: 2.2%). The mean percentage of drives under the influence of multiple drugs[90] was 1.8%, most of which under the influence of alcohol and cannabis (1%). For all other reported drugs (LSD, sedatives, psilocybin, GHB, salvia divinorum, non-prescribed methylphenidate), no substance-positive drive was found. It turned out that users drove more than twice as often under the influence of alcohol (5.4% - thereof 1.3% combined with other substances) compared to controls (2.2%). For alcohol and cannabis, concentration-dependent data were provided. The cut-off values that were used to define a drive as drive under influence are rather low (BAC≥0.01%, THC blood plasma level≥1ng/ml). When applying higher cut-off values, like a BAC of 0.05% and a THC blood plasma level of 4ng/ml[91], the mean percentage of DUI within the user sample drops by around 40% from a previous 20.5% to 13.1%.

How high is the proportion of DUI in the general population (estimated by the survey results)?

Via existing mobility measures and prevalence data for drug use in Germany (MiD 2008, ESA 2006), the survey results were extrapolated into alcohol and THC prevalence rates for the general German driving population – assuming that 40-year-olds and older do not drive after the consumption of illegal drugs because the drug prevalence rate for this age group is very low[92]. According to this estimation, the prevalence of THC-positive drives (THC blood plasma level≥1ng/ml) in Germany is 0.14% (95% CI: 0.09% - 0.2%). For drives under the influence of stimulants (cocaine in- or excluded), the prevalence is 0.02% (95% CI: 0.01% - 0.04%). For drives under the influence of multiple drugs (any drug combination, alcohol included), the prevalence is 0.02% (95% CI: 0.01% - 0.03%). For drives under the influence of alcohol in combination with an illegal drug, the prevalence is 0.01% (95% CI: 0.006% - 0.02%). Because of the high prevalence of risky alcohol consumption in the population older than 39 years[93], this age group cannot be neglected in the case of alcohol. The calculation of the alcohol prevalence (BAC≥0.01%) was therefore limited to the 18-24- and the 25-39-year-old German population. For the 18-24-year-old German population, it is 1.57% (95% CI: 0.52% - 2.7%) and 3.3% (95% CI: 1.63% - 5%) for the 25-39-year-olds.

Compared to the results of the German roadside survey from 1994 (cannabis: 0.57%; alcohol: 3.76 for 18-24-year-olds, 5.48 for 25-49-year-olds; Krüger et al., 1996), the prevalences that were found within the present study seem pretty low. However, amendments to traffic regulations for drink and drug driving within the last several

[89] Amphetamine, ecstasy, cocaine.
[90] Cannabis/alcohol, cannabis/stimulants, alcohol/stimulants, cannabis/heroin, cannabis/alcohol/stimulants.
[91] According to Berghaus, Sticht and Grellner (2011), a THC blood plasma concentration of 3.8ng/ml corresponds to a BAC of 0.05% concerning the performance impairing effects of the substance.
[92] 30-days-drug-prevalence of 40-64-year-old population: 0.7% / regular drug use (>3x in last 30 days): 0.3% (ESA 2006).
[93] Prevalence of risky to high alcohol consumption of 40-49-year-olds: 11%, of 50-59-year-olds: 13.2%, of 60-64-year-olds:14.4% (ESA 2006).

years might serve as an explanation for changed prevalence rates for drives under influence in Germany. In 1998, the legal BAC limit for driving a motor vehicle in traffic was lowered from 0.08% to 0.05%. Moreover, the 0.00% BAC limit for novice drivers[94] was introduced in 2007. A decreasing trend concerning alcohol drives within the last several years can also be shown by other traffic related parameters. Alcohol-related accidents (Vorndran, 2009) or alcohol related records at the Central Register of Traffic Offenders (Federal Motor Transport Authority – Jahresbericht 2004, Jahresbericht 2009) have decreased within the last several years. Furthermore, it was not until 1998 that a law was introduced in Germany that makes driving under the influence of illegal substances an offence in the first place. Since then, the screening of illegal drugs in traffic has become more prevalent and the detection devices more precise. So, the probability of being stopped by the police and getting detected while driving under the influence of an illegal drug has become higher. Because of the higher deterrence effect, drug users may have altered their drug driving behaviour towards more conformity with the law within the last several years.

By comparing the results of the 13 European roadside surveys that were conducted within Work Package 2 of DRUID (Houwing et al., 2011a; Houwing et al., 2011b) with the results of the present study, it was found that the prevalences of THC-positive drives for the 18-49-year-old population of most countries are close to the German result (~less than 0.5%). Exceptions are the prevalences found in Spain, Italy, Portugal and the Netherlands. In these countries compared to the other countries, the prevalence of THC-positive drives in the 35-49-year-old population is rather high. In Portugal and the Netherlands even the 50+ population has by itself a prevalence of THC-positive drives of around 0.5%. Furthermore, it turned out that the prevalence of alcohol-positive drives found for the 18-24-year-old German population is best comparable with the prevalence found for the 18-24-year-old population in Belgium, Italy, Lithuania and Portugal (~1-2%). The same countries plus Spain found alcohol-prevalences for 25-49-year-olds that are comparable with the German prevalence for the 25-39-year-old population (~2-4%).

In addition to the estimation of the prevalence of DUI in Germany, the study pursued the aim of providing information about situational characteristics of drives under influence and personal attributes of persons who commit them. The great advantage of the present study is that not only information about one single drive of a person is available. Instead, information about each trip and each drug intake of a person that took place over an extended period of time can be observed. Thus, the typical drug use, driving and drug driving patterns of a person within the typical situational context can be analysed.

[94] All drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence.

Situational aspects associated with drug use and DUI

The data that were gathered by the daily questionnaire referred to daily activities, daily trips, drug consumption, driving, the frequency and circumstances of DUI and decisions against DUI of users and controls, respectively.

How do people spend an average day?

When and what kind of substance do people use?

The results show differences between users and controls on several variables. It was found that users are awake longer at night compared to controls. From 9pm until approximately 5am, substance consumption took place in around fifty percent of the time. On weekends, this proportion was even higher and spanned further into the morning. In general, controls are more often out at public places, whereas users spend more time at friends' – on weekends the whole day, on weekdays especially at night. Cannabis is the most commonly used drug, especially in the daytime. In the evening, the proportion of alcohol use, alone or in combination with cannabis, increases. In the early morning hours, the consumption of other drugs than alcohol and cannabis increases strikingly. Outside of alcohol and cannabis, stimulants are the most often used drugs. By trend, females use stimulants more often than males. In total, 29.2% of the 65 users (33.3% of all users) who currently use stimulants use the drug on more than six occasions per month. The remaining stimulants users use it less frequently. Users drink alcohol more frequently and in higher doses compared to controls. 12.8% of the users are excessive alcohol users, whereas only 3% of the controls are in this consumption group. Males drink more alcohol than females, as do younger subjects compared to older ones. Subjects from city and urban areas drink more alcohol compared to subjects from rural areas. This might be due to the fact that people have less opportunity to go out and drink alcohol in rural areas. In urbanised areas, there are more restaurants, bars and clubs – places to go out to and places where people usually drink alcohol. Cannabis is used more often by younger subjects compared to older ones. Besides, subjects from rural areas use cannabis more often than subjects from urban areas. This again might be due to the restricted offer of public places to go out to in rural areas. Therefore, more illegal substance consumption might take place as people more often stay at private locations. 23.1% of the users who were surveyed consume two or more joints a day, whereas the remaining cannabis users within the study use cannabis less often. In general, the subjects never evaluate their consumption behaviour as highly problematic, regardless of the substance they use.

When do people drive a vehicle and when do they use other modes of transport?

In general, users are more mobile at night compared to controls who are more mobile at usual rush-hour times. So, the controls' days proceed more along a daily working routine. Even if users are out more on weekends, controls drive more at that time. Users use other modes of transport instead. They walk or use a bicycle more often at night compared to controls. Moreover, they travel more often by taxi. Thus, there is a higher need or willingness among users to go by alternative modes of transport

instead of driving. Female subjects, 18-24-year-olds and subjects from urban or city areas especially use other modes of transport instead of driving. Female subjects often travel as passenger, much like young subjects do. 18-24-year-olds also use public transport more often than older subjects who drive a car more often instead. Urban and city mobility is characterised by a high proportion of trips by foot, bicycle, public transport and the use of taxi. In rural areas, the proportion of motorised private transport either as driver or as passenger is higher instead.

What are the situational characteristics of DUI and decisions against DUI?

On weekdays, the users have on average 3.4 trips per day and 3.1 on weekends. On weekdays, 1.9 (54%) of the trips are drives compared to 1.3 (43%) on weekends. On weekdays, users drive on average 19% of all drives under the influence of alcohol, cannabis or other substances or drug combinations (mainly cannabis). On weekends, this number rises to 32% of all drives. At night-time between 9pm to 4-5am, on weekends even until 8-9am, around 50% of the users' drives are under influence. The controls' positive drives are basically restricted to common times for going out (8pm-2am).

Drives under the influence of cannabis are committed quite often at any time of the day, on weekdays especially in the evening, on weekends also late at night. Drives under the influence of alcohol most often occur in the evening/at night, on weekends additionally in the morning/afternoon due to residual effects from drinking the day before. Drives under the influence of stimulants most often occur on weekends, mostly in the evening/at night, but also quite often in the morning/afternoon.

Other factors of influence on DUI are the distance, the availability of alternative modes of transport and the presence of companions. On short trips (<5km), the persons refrain from driving many times but they still drive fairly often under influence. They probably do not see an increased risk of having an accident or getting caught because of the short time and distance of being on the road. On longer trips, the percentage of abstaining from consumption or of restricted consumption due to driving increases. A drive under influence occurs least likely if a drive has a distance of more than 25km. It also turned out that THC-positive drives occur more often in rural and city areas compared to urban areas. Apart from different consumption patterns, this might in part be due to the fact that in urban areas the distances that have to be covered to reach usual destinations are shorter than in rural and city areas. Thus, using alternative modes of transport – especially at night, when public transport runs less often – is much easier in urban areas. The subjects can walk or use the bicycle instead of driving. So, the persons are free to choose between driving or using other transport[95]. Even if in bigger cities the availability of public transport in general is high, this offer is limited at times when drug driving is most prevalent, i.e. at night and on weekends. When subjects face the conflict to choose between drug driving and avoiding it, they most often commit drug

[95] From the interview with the subjects, it is known that some subjects from rural areas have access to a night bus that is employed in particular for young people who go out at night to avoid drug driving. The subjects said that they make use of this alternative mode of transport quite willingly and quite often.

driving when they travel alone and least often when they travel with companions of both genders. The results also suggest that when having only female companions while driving, the probability of driving under influence is lowered, especially when the driver is male. If a male and a female person accompany each other, males more often decide against and females more often decide towards DUI.

Person-related factors of drug use and DUI

Does everybody who uses drugs and drives regularly commit DUI?

Furthermore, it was shown that not all persons per se drive after the consumption of illicit drugs or alcohol. Within the control group, 61% (CI: 51.4% - 70.6%) do not drive with a BAC above the legal limit. Within the user group, the percentage of persons who do not commit DUI is lower. 14.4% do not drive under influence at all (CI: 9.5% - 19.3%). 80% of the users' BAC- (BAC above the legal limit) and THC-positive drives (THC≥4ng/ml) were committed by only 20% of all users. Compared to controls, drug users drive more than twice as often under the influence of alcohol. Furthermore, users underestimate and controls overestimate how often they drive under influence. Controls also more often stated to have restricted their consumption because of driving.

Do people who drive a lot commit more DUI than others?

When it comes to the frequency of driving, it became apparent that persons who in general drive less frequently more often avoid driving under influence by refraining from driving because of previous consumption, whereas the others more often refrain from or restrict consumption.

It was found that the driving frequency has an influence on the occurrence of THC-positive drives. The more frequently a person uses a vehicle, the more drives under the influence of cannabis he/she commits. In contrast to alcohol and stimulants, which are mainly used at night-time, cannabis is more likely used all day long. When someone smokes a joint in the morning, all subsequent drives within approximately six hours after consumption are THC-positive drives. The greatest part of drives is travelled at daytime. At night, driving occurs rather infrequently. So, if someone uses drugs at night, it is less likely that a drive follows and more likely that a sleeping period lies between consumption and driving. Therefore, it is not surprising that the driving frequency has an influence on the occurrence of THC-positive drives within the present sample but not on the occurrence of alcohol- and stimulants-positive drives.

Do heavy users commit more DUI than others?

A striking predictor for frequent drug driving and highly intoxicated driving in general is frequent consumption. Excessive and to some part heavy users more often consume at all times of the day and on all days of the week, whereas moderate users restrict their consumption for the most part to weekends and evenings/nights. At the same time, excessive substance use was shown to be associated with a lower

subjective feeling of impairment. Consequently, it is not surprising that excessive substance users commit most substance-positive drives, have higher substance blood levels while driving and less often decide against drug driving compared to moderate or heavy drug users.

For moderate and heavy users, a positive correlation between the height of the substance blood concentration and the subjects' statement about their feeling of impairment while driving was found. The higher the blood concentration, the more they feel impaired. A medium impairment of moderate users corresponds to a median BAC of 0.03% and a median THC blood plasma level of 3.7ng/ml. A medium impairment of heavy users corresponds to a median BAC of 0.05% and a median THC blood plasma level of 7.5ng/ml. In the case of excessive users, the corresponding values are a BAC of 0.08% and a THC blood plasma level of 18ng/ml.

In general, excessive users rather seldom feel highly impaired but commit more highly intoxicated drives with respect to the calculated BACs and THC blood plasma levels. Excessive users have the highest (BAC: MD=0.07%; THC: MD=7.7ng/ml) and moderate users the lowest blood levels (BAC: MD=0.03%; THC: MD=3.2ng/ml). Heavy users have lower blood levels than excessive and a little higher ones than moderate users (BAC: MD=0.04%; THC: MD=4.5ng/ml) when driving under influence.

Excessive users less often decide against drug driving compared to moderate and heavy users. Heavy and moderate users often refrain from driving. Additionally, moderate users marginally more often abdicat consumption. All in all, it turned out that the more one consumes, the less likely the person will refrain from consumption in order to avoid driving under influence.

For alcohol a dose-dependent decision making according to the present legal restrictions in Germany was found. When the subjects, regardless whether users or controls are considered, consciously drive after alcohol consumption, the median BAC lays below the main legal BAC limit of 0.05%. When they restrict alcohol consumption because of driving, the median BAC is even lower than 0.03%, which is the threshold for fitness to drive in Germany. When the subjects refrain from driving because of previous alcohol consumption, the median BAC is as high as or higher than the main legal BAC limit in Germany (corresponding THC blood plasma levels for condition *consumption as usual*: 8ng/ml, *restricted consumption*: 4ng/ml, *previous consumption*: 6ng/ml) .

These findings could be an indicator for the positive effect of the implementation of thresholds for driving under influence of e.g. cannabis, especially for rather moderate consumers. Thresholds, like the 0.05% BAC limit, allow the substance user to develop a realistic judgement of impairment according to the consumed dose, the time delay since the last consumption and the subjective feeling of impairment.

Does accute cannabis intoxication and long-term drug use affect the psychometric performance measured by the computer-based Act & React Test System (ART) 2020 Standard test battery?

The psychometric performance was assessed by the application of the computer-based Act & React Test System (ART) 2020 Standard test battery that was developed by the Austrian Road Safety Board (ARSB). Seven sub-tests of the test battery were applied, which measure the following performance dimensions: coordination capacity (LL5, PVT, SENSO), concentration and attention capacity (Q1), reaction capacity (RST3), stress resistance (RST3), memory capacity (GEMAT3) and intelligence (MAT). Five of the seven tests can be assigned to the performance dimensions listed in the German Driver's Licence Ordinance ("Fahrerlaubnis-Verordnung", FeV). It was found that users who are under the influence of cannabis (calculated THC blood plasma level>0ng/ml) perform worse compared to sober users. Acute intoxication resulted in a tendency to make more mistakes. In three of all seven sub-tests, the acutely intoxicated subjects have a higher percentage of errors and/or less correct responses (Q1, GEMAT3, RST3). These tests are measures to assess concentration and attention capacity, reaction capacity, stress resistance and memory capacity. Besides, it was investigated if any negative long-term performance effects of drug use can be shown. The analyses showed that heavy lifetime drug use (heavy drug use: use of cannabis and so called "hard" drugs, light drug use: mainly use of cannabis) is associated with fewer correct responses, more omissions and in part fewer processed items. In four of all seven sub-tests heavy users perform worse than light users and controls on single parameters, namely in the MAT, the GEMAT3, the LL5 and the RST3. These tests are measures to assess intelligence, memory capacity, coordination capacity, reaction capacity and stress resistance. In the LL5 and the RST3 (measures for coordination capacity, reaction capacity and stress resistance) light users make fewer errors than controls. Concerning all other parameters no differences were found.

Although evidence was found that acute cannabis intoxication partly affects the psychometric performance and that negative long-term performance effects of heavy lifetime drug use exist (while light lifetime drug use has no negative impact), the results have to be interpreted with care. The found differences were very small. Of 39 parameters measured by the ART2020, only 5 turned out to be significantly different between the study groups. Another 7 only showed trends. The recommended evaluation of the ART2020 according to the Guidelines for Expertise on Driver Aptitude ("Begutachtungs-Leitlinien zur Kraftfahrereignung"; Lewrenz, 2000) resulted in high overall failure rates of 58% to 69%, no matter which study group is considered (control group included; Annex 17.7). The highest failure rates were found for the PVT, the Q1, the RST3 and the SENSO. Relatively low failure rates were found for the GEMAT3, the LL5 and the MAT. The calculation of the test sensitivity and the test specificity indicates that the recommended evaluation procedure is neither sensitive nor specific enough to make clear assumptions about a possible relation between the degree of drug use – as operationalised in the present study – and psychometric performance.

The assignment of the subjects to the study groups that were analysed with respect to their performance on the ART2020 is based on the urine screening result and the presence or absence of an acute intoxication[96]. The acute intoxication, in turn, is based on the calculation of substance blood concentrations (described in Chapter 13). For this calculation, approved mathematical models were used (Widmark formula, Widmark, 1932; THC elimination curve by Sticht, personal communication, December 2009). Nevertheless, the calculation is and will remain only an estimation of the real intoxication. The lacking evidence of objective intoxication by a blood screening constitutes the major constraint of the ART2020 analysis. Concerning the analysis of the effect of lifetime drug consumption, it further has to be kept in mind that the subjects that were surveyed in the present study rather seldom used so called “hard” drugs in their life. The most frequently used drug was cannabis accompanied by a more or less frequent consumption of amphetamines and hallucinogens. A more precise effect might have been found if users with a heavier lifetime drug use (including heroin) would have been investigated.

Do subjects who were conspicuous in road traffic before (measured by the records in the Central Register of Traffic Offenders) commit more DUI compared to those who had no entry in the register?

One question that arises while studying the phenomenon of drug driving is if drug driving is a single problem or if drug driving is indicative of other traffic related problems as well. The present study was able to demonstrate that based on the records that are stored in the German Central Register of Traffic Offenders – except from offences considering drug driving – users are not more conspicuous in road traffic than controls. Furthermore, subjects who were conspicuous in traffic before do not inevitably commit more DUI. It was also found that getting caught because of DUI seems to have no preventive effect on drug driving since subjects who had lost their license or had a driving ban (N=14) due to DUI offences in the past are not characterised by a lower number of current drug driving compared to those who had no DUI offence stored in the German Central Register of Traffic Offenders.

Do subjects who reported dangerous traffic situations while participating commit more drives under influence compared to those who had no dangerous traffic situation?

It was shown that those who reported self-inflicted dangerous traffic situations did not commit more DUI while participating. Thus, except from driving under influence, there is no evidence to suggest that DUI offenders show problematic behaviour in other traffic-related measures as well.

[96] Analysis of acute effects of cannabis (Inclusion criteria: Urine negative for amphetamines, cocaine, opiates, positive for cannabis, calculated BAC=0.00%): Acutely cannabis intoxicated users (THC blood plasma level>0ng/ml) versus sober users (THC blood plasma level=0ng/ml),
Analysis of long-term effects of drug use (Inclusion criteria: Urine negative for amphetamines, cocaine, opiates, negative for cannabis or positive for cannabis and calculated THC blood plasma level=0ng/ml, calculated BAC=0.00%): Sober users with high lifetime drug use versus sober users with light lifetime drug use versus controls.

Are there differences in personality between users and controls and between those users who commit DUI and those who do not?

According to evidence from a literature review that was conducted prior to the study, questionnaires that specify personality dimensions that are relevant in the context of drug use and drug driving were applied. It was found that users are to a greater extent sensation seekers than controls. They reported more symptoms of hyperactivity/impulsivity in their childhood as well as more negative psychological and social after-effects due to AD(H)D symptoms. On the other hand, they more often stated that psychoactive substances have a relieving effect on AD(H)D symptoms. Furthermore, they indicated to a greater degree to use psychoactive substances as a coping strategy in the case of feelings of distress. They are more open to new experiences and are motivated in response to cues for reward. Accompanied by a reduced motivation in response to cues for punishment, this is thought to increase the probability of unlawful behaviour in traffic (Castellà & Pérez, 2004). Users take the view that life and the occurrences therein rely on fate and fortune, whereas controls believe in their own scope of influence. An external locus of control is suggested to be related to a lack of caution and failure to take precautionary steps to avoid the occurrence of unfavourable outcomes (e.g. Hoyt, 1973). Moreover, it turned out that users are less conscientious than controls and, with regards to their own driving behaviour, more aware of fallibility. Besides, drug users are less embarrassed when they infringe social norms. In sum, drug use seems to be associated with some crucial personality dimensions (e.g. sensation seeking, hyperactivity/impulsivity, less self-control, rather unconventional behaviour) and drugs seem to be misused to solve personal problems (e.g. psychological and social problems due to hyperactivity/impulsivity, feelings of distress). A less precise but similar difference was found for users who commit many drives under influence compared to users who never or only sometimes drive under influence. Users at high risk of driving under influence reported more symptoms of hyperactivity/impulsivity in their childhood as well as more negative psychological and social after-effects and that psychoactive substances have a relieving effect on symptoms of hyperactivity/impulsivity. Users who often drive under influence expressed having less positive coping strategies and believe much more pronounced that life and the occurrences therein rely on fate and fortune as compared to users who rather seldom drive under influence.

Are users compared to controls more at risk of mental illness?

To assess any psychological problems of the subjects, the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I) was conducted (Wittchen et al., 1997). Additionally, the subjects were queried about former psychological problems that were diagnosed by physicians. The number of diagnoses per person (Substance Use Disorders excluded) tends to be higher for users compared to controls. Users were more often than controls diagnosed with a Mood Disorder (i.e. Major Depression with Recurrent Episodes and marginally more often Bipolar Disorders), AD(H)D and marginally more often with a Borderline Personality Disorder (lifetime prevalence). On the other hand, controls more often received the diagnosis of Panic Disorder without Agoraphobia. With respect to (lifetime) Substance Use Disorders, users were most

often diagnosed with Alcohol, Cannabis and Multiple Drug Abuse or Dependence. Furthermore, the diagnosis Amphetamine Abuse and Abuse of Other Drugs (sniffing agents, methylphenidate) was quite common. Less common but still more often diagnosed than in the control group were the diagnoses Amphetamine, Cocaine and Opiates Dependence as well as Sedatives and Hallucinogens Abuse. Moderate, heavy and excessive users of alcohol, cannabis and stimulants not only differ depending on the amount that they consume per day/month. They also differ depending on the reported effects of substance consumption on their well-being. The higher the consumption, the higher the clinically significant impairment or distress expressed by the subjects in the SCID-I interview and the higher the intention to change/stop substance consumption is. When Dependence was diagnosed, the most often fulfilled criteria were *tolerance*, *time costs* and *loss of control*. In the case of Cannabis and Stimulants Dependence, a *desire to change* and in the case of Cannabis Dependence alone, *withdrawal* symptoms (i.e. sleeplessness, restlessness, bad temper) were reported quite often. When Abuse was diagnosed, the most often fulfilled criterion was *endangerment* through substance use (i.e. driving or operating machines under influence).

The prevalence of Mental Disorders that were found in the present survey was higher than within other studies (MFS, NEMESIS, cited in Meyer et al., 2000; Tacos, Meyer et al., 2000). Three possible explanations were laid out: Firstly, the sample of the present study was younger and more recently investigated than the samples of the other studies. According to Kessler et al. (2005), the lifetime prevalence estimates of mental disorders are higher in recent cohorts than in earlier cohorts. Secondly, reluctance by the subjects to report embarrassing behaviours might be lowered because the study setting was very open and unforced. And thirdly, the sample of the present study was not randomly selected. Instead, it was recruited by media campaigns and word-of-mouth-recommendation. Thus, the sample could selectively consist of people who are more interested in psychological research and this, in turn, could be due to a higher proportion of psychological problems than average.

Can social influences be identified that are associated with drug use and DUI?

Social learning and Social Control Theory stress the influence of parents and peers on the behaviour of a person (Bahr et al., 2005). Social learning theory proclaims that an individual acquires positive attitudes towards behaviour that is modelled by persons with whom frequent and intense interactions take place and to whom they look up to. By the present study, it could be shown that the higher the subjects grade their parents' alcohol consumption, their peers' and partner's drug use and their peers' drug driving, the more they themselves are involved in the behaviour. Anyhow, it has to be kept in mind that the present study design does not allow a causal attribution. On the one hand, a person could e.g. use drugs and drive under influence because persons who are close to him/her do so, too. On the other hand, persons who show the behaviour in question might selectively choose friends and a partner who show the behaviour as well.

Social Control Theory states that social control may influence behaviour (Bahr et al., 1998; Hirschi, 1969, cited in Bahr et al., 2005). The social bond that a person has

with society is proclaimed to be crucial for the occurrence of deviant behaviour. One critical bond identified by Hirschi (1969, cited in Bahr et al., 2005) is the one to parents. A good attachment to parents helps adolescents accept conventional values and prevents them from deviant behaviour. Users who were surveyed in the present study indicated that their relationship to their parents was worse than the controls', especially those who commit intoxicated driving quite often. But the found differences between the study groups were rather small. Nevertheless, users, and especially those with many drives under influence, declared that their parents were more worried about them and mistrusted them to a higher degree than controls. By contrast, controls stated to a higher extent that they were raised to achieve a greater degree of autonomy and that their connection with their parents was respectful. In this context, the finding that users scored higher on the scale *Openness to experiences* of the NEO-FFI should be mentioned. Persons with a high score behave, amongst other things, more unconventionally and try out new ways of thinking and acting. Persons with a low score tend to behave conventionally and to have conservative attitudes. Because users described the relationship to their parents worse than controls, this finding goes in line with the above mentioned connection between a good attachment to parents and the resulting acceptance of conventional values that is thought to lead to desisting from deviant behavior.

In the same way, parental monitoring is thought to influence delinquent behaviour. The more a person feels watched and supervised by his/her parents, the less likely he/she commits delinquent behaviour (Bahr et al., 1998; Hirschi, 1969, cited in Bahr et al., 2005). Users stated that their parents' way of raising them was more lenient as compared to the controls' statements. The lack of strength in parenting might bring forward a tendency of the child to behave delinquently, in the present case to use drugs and to drive under influence. Another indicator for a lower supervision by the parents might be the found tendency that the users' fathers have a higher job position and are therefore thought to have been less involved in bringing up the child. Besides, the users more often stated that their parents lived apart or were divorced compared to controls. Contrary to this argumentation, it was found that the fathers of users who commit many drives under influence have lower job positions than the fathers of users who drive rather infrequently under influence. The parents of these two study groups do not differ with respect to living apart or being divorced.

Can attitudes be identified that are associated with drug use and DUI?

If the controls' willingness to use a substance is interpreted as general social acceptance, then the use of alcohol is highly socially accepted (98%), the use of cannabis is partly socially accepted (47%) and the use of other drugs is least socially accepted (8-15%).

Attitudes towards drug driving

Based on Fishbein and Ajzen's (1980) theory of reasoned action, attitudes and subjective norms predict behavioural intention and actual behaviour. Within the framework of the present study, several questions concerning the mindset of the subjects towards drug driving were asked. While controls find driving under the influence of cannabis as condemnable as driving with four beers or more or under

the influence of sedatives, users have fewer objections to drive while intoxicated by cannabis. Driving with four beers, under the influence of amphetamines, sedatives or cocaine is in the users' view to about the same extent condemnable and more condemnable than driving under the influence of cannabis. For both study groups, drives under the influence of ecstasy, opiates and hallucinogens are most condemnable. For controls, drives under the influence of amphetamines and cocaine are also equally condemnable. Users who themselves drive often under influence are less adverse to going along with an intoxicated driver compared to users who rather seldom drive under influence. Further on, subjects who rather often drive under influence say that their friends have a less adverse attitude towards DUI, compared to subjects who do not drive under influence or do it rather infrequently.

Motives against drug driving

The decision to drive under influence is stated to mainly depend on characteristics of drug intake (amount, type and effect of consumed drug, time of drug consumption). Users who rather seldom drive under influence state a higher priority of the time of drug use compared to users who often drive under influence. The density of police controls, whether or not passengers could be endangered and the possible option of riding along with another person are also quite relevant in the decision making process. Other possible alternative modes of transport, route characteristics as well as the presence and reactions of companions are also stated to be of relevance, although less pronounced.

Attitudes towards thresholds

Many users say that they would appreciate a threshold for driving under the influence of cannabis. The most frequently specified reasons were the long traceability of the substance in body fluids and a feeling of injustice compared to persons who drink and drive. Even though controls would not benefit from it, they agree to a great extent that the introduction of a threshold for cannabis would be reasonable. Users who drove under the influence of cannabis while participating in the study were more often in favour of a threshold compared to users who would not be affected by a threshold because they currently do not drive after cannabis consumption.

Most controls accept the implementation of the zero-tolerance for young and novice drivers for driving under alcohol influence. Of the users, fewer subjects, but nevertheless quite many, advocated the zero-tolerance. With reference to different age groups, again, subjects who are affected the most (in this case young subjects versus older subjects) are less enthusiastic about the zero-tolerance. The subjects were further asked how high the alcohol limit should be in their opinion. Controls more often take the view that the legal BAC limit should be lower than 0.05% compared to users who more often state that it should be higher. The same is true for subjects who moderately drink alcohol compared to heavy and excessive alcohol users. The view that someone can drink higher amounts of alcohol and still has the ability to drive safely is associated with a higher alcohol tolerance because, again, a clear difference between moderate and heavy/excessive users was found (moderate users state lower amounts).

General attitudes

Users compared to controls are less satisfied with their personal life situation and are less aware of a healthy way of living. This finding shows, again, that the consumption of drugs has a negative impact on the well-being of a person. And this, in turn, shows the potential of therapeutic intervention strategies to combat DUI.

For users compared to controls, obeying the law is a less important ethical principal. On this score, no difference was found for moderate, heavy and excessive drug users or for users who commit many and users who commit no or only a few drives under influence.

So, drug users have rather liberal attitudes towards driving under influence. For them, it does not pose an exceptional or condemnable behaviour and obeying the law appears to be of minor matter.

Does sanctioning and enforcement deter from DUI?

Knowledge

Experienced drivers have a better knowledge of the alcohol-related traffic legislation than young and novice drivers[97]. The sanction for violations against the 0.00% BAC limit was assessed to be almost as high as the sanction when violating the 0.05% BAC limit, although it is actually lower. Users and controls do not differ in their knowledge about the alcohol-related traffic legislation (number of BAC limits and correct specification of consequences when violating the main BAC limits), but controls generally expect the sanctions to be lower. Users compared to controls have a better knowledge of the legal consequences that are imposed when being caught while driving under the influence of illegal drugs. However, they expect it to be lower than it was defined in the present peace of work. In the case of driving under the influence of illegal drugs, they are often not aware of the different sanctioning stages according to the StVG[98], the StGB[99] and the FeV[100], respectively.

The analysis of the knowledge about the legal consequences when committing an offence due to illegal drugs, has to be regarded as a rough approach to gain an insight into the topic. When treated like an administrative offence according to § 24 StVG (in the case of no signs of impairment), the offender will be punished with four demerit points, a 500 euros penalty and a one month driving ban. But because offences due to illegal drugs are punished according to the StVG, the StGB and the FeV, respectively, the reality in most of the cases looks more ambiguous and the

[97] Experienced drivers: correct specification of driving ban (in months), penalty (in euros), number of points and correct assignment of criminal proceedings for violations of the 0.05% and 0.11% BAC limits and mentioning of existence of 0.00%, 0.03% and 0.16% BAC limit.
Young/novice drivers: correct specification of driving ban (in months), penalty (in euros), number of points and correct assignment of criminal proceedings for violations of the 0.00% and 0.11% BAC limits and mentioning of existence of 0.05%, 0.03% and 0.16% BAC limit.
[98] Straßenverkehrsgesetz: German Road Traffic Act.
[99] Strafgesetzbuch: German Penal Code.
[100] Fahrerlaubnisverordnung: German Driver Licensing Act.

sanctions are likely to be higher. If someone gets caught while driving under the influence of illegal drugs, in most of the cases a medical and psychological assessment (MPA) according to the FeV is ordered. An MPA is accompanied by a withdrawal of the driving licence until the MPA is positively passed. So, even if the driving ban is actually only one month in accordance with § 24a StVG, the driving licence is often withdrawn for around one year (until an ordered MPA is positively passed). Moreover, in the case of illegal drugs, the probability that criminal proceedings will follow – either according to the StGB (because of signs of impairment) or the BtMG[101] – is rather high. So, for illegal drugs the specification of a withdrawal/driving ban of several months, the order of a MPA and subsequent criminal proceedings was considered as correct specification when analysing the subjects' knowledge of legislation.

Deterrence effect of stopping probability

The perceived risk of being stopped by the police has an influence on the occurrence of DUI. The more probable a person thinks a police stop could occur, the more often the person decides against DUI.

Deterrence effect of detection probability

Users grade the detection probability when being stopped by the police while driving under the influence of cannabis and stimulants (the main categories of DUI within the present study) lower than controls. With respect to other substances, no differences were found. The perceived detection risk has no influence on the number of drives under influence. An effect was found for gender. Males assess it more likely than females that the police will recognise the influence of alcohol. Females believe that it is more likely to be detected when being stopped by the police after consuming sedatives. Moreover, 18-24-year-olds evaluate it as more likely to be detected after the consumption of stimulants than 30-39-year-olds. If effects concerning the subject's residence reached significance, this usually indicated that people from rural areas and bigger cities perceive the detection risk as less likely compared to subjects from smaller cities (i.e. the detection of amphetamine, ecstasy, LSD/psilocybin).

Deterrence effect of punishment severity

Demerit points seem to have a lower deterring effect compared to driving bans and fines. It was also found that users who commit no or only some drives under influence would be deterred by lower penalties (up to 500 euros) compared to users who often drive under influence (up to 1,000 euros).

To find out if sanctions have an effect on the frequency of DUI, the perceived sanction severity was analysed. Experienced drivers tend to drive more often with BACs above the legal BAC limit (0.05% BAC limit) when the subjective sanction severity is low compared to when it is high (classification by median-split). But this effect did not reach significance. The results found for young and novice drivers (when considering their mean percentage of drives with BACs above zero) and for

[101] Betäubungsmittelgesetz: Controlled Substances Act.

users (when considering their mean percentage of drives under the influence of illegal drugs) go in the same direction but are far from reaching significance. This rather small, only marginally significant effect of the subjective sanction severity on the occurrence of DUI is accordant with what can be found in the literature (Ross, 1992, Homel, 1988, cited in Albery & Guppy, 1995).

Effect of legal BAC limit on alcohol-positive drives

In Germany, the 0.00% BAC limit applies for novice drivers, i.e. all drivers between the ages of 18 and 21 and newly licensed drivers of any age for the first two years of having a licence. For all other drivers, the 0.05% BAC limit applies. 18-24-year-olds drive less often under the influence of alcohol when the 0.00% BAC limit applies compared to when the 0.05% BAC limit applies. But this effect is only significant for controls. Users do not drive less often with a positive BAC when the lower limit applies.

It further turned out that for controls (not for users) the legal BAC limit has also a corresponding effect on their attitude towards driving after one beer. The 18-24-year-old controls for whom the zero-tolerance applies find it to a small degree more condemnable to drive after one beer than those 18-24-year-old controls for whom the 0.05% BAC limit applies.

This finding, together with the finding concerning the subjective feeling of impairment, and the perceived risk of being stopped/detected go in line with Ajzen's (1985) theory of planned behaviour, which adds the concept of perceived behavioural control to the theory of reasoned action (Fishbein & Ajzen, 1980). The theory states that an individual's perceived ease in performing a behaviour (in the present case a low subjective feeling of impairment and a low perceived stopping/detection probability) may increase the likelyhood that the behaviour is shown. Both theories, the theory of planned behaviour and the theory of reasoned action, are often referred to when programmes and strategies that aimed at reducing health risk are designed.

Integration of the results

In conclusion, the results of the present piece of work were integrated in a model that shows dependencies of different societal, behavioural and legal variables that are relevant for combating driving under influence (Chapter 15).

16.3 Implications for prevention and rehabilitation

The following insights can be drawn, which might be relevant for the discussion about drug driving and associated prevention and rehabilitation measures.

The most striking predictor for drug driving is the consumption frequency. Moderate users and to some degree heavy users in contrast to excessive users seem to be able to separate drug use from driving. Their proportion of drives under influence of all drives and the substance concentrations while driving intoxicated were found to be

rather low. Their subjective impairment while being under the influence of a substance correlates to some extent with the actual intoxication. Excessive users more often developed a tolerance to the substance they use. So, it is not surprising that no correlation between the subjective impairment and the objective intoxication was found in the case of excessive users. Excessive and to some part heavy users use drugs at any time of the day, whereas moderate users restrict drug consumption to weekends and to evenings/nights. Prevention and rehabilitation measures should be addressed to the main target group of heavy and excessive users. This user group often reported more clinically significant impairment or distress due to substance use and expressed a higher intention to change/stop substance consumption. So, aligning preventive measures with therapeutic measures to reach the target group of risky drug users might be an appropriate approach to reduce drug driving.

Evidence was found that attitudes and social norms play an important role in the context of drug driving. If users downplay the danger of driving under the influence of a psychoactive drug or believe that driving while being intoxicated is a rather common behaviour, the occurrence of drug driving increases. Many users say that they would appreciate a threshold for driving under the influence of cannabis. Controls as well – although to a lower degree – support a threshold for cannabis. The most frequently specified reasons were the long traceability of the substance in body fluids and a feeling of injustice compared to persons who drink and drive. Pfeifer and Hautzinger (2001, cited in Gelau & Pfafferott, 2009) suggest that the severity of sanctions should reflect the severity of the offence. If users do not think it is more severe to drive under the influence of cannabis (e.g.THC blood plasma level=4ng/ml) than under the influence of alcohol (e.g. BAC limit=0.07%), a higher penalty for drug offences will not be accepted and the willingness to obey the law will be cut down. This implicates the importance of informative measures in the context of efforts to combat drug driving. Information about the real risks and the real extent of drug driving should be disseminated to create a better awareness of risks in traffic. Furthermore, friends and family members of exposed persons should be addressed and should be made aware of their influence and responsibility in the process of developing problematic attitudes and, thus, problematic behaviour.

It was shown that to some extent sanctioning and detection deters from drug driving and that drug driving is most common on weekends and at nights, on weekends even until the morning hours. To maximise the deterrence effect, police controls should be unpredictable and should be expected at any time and at any place (Gelau & Pfafferott, 2009). Mathijssen and Noordzij (1993, cited in European Transport Saftey Council - ETSC, 1999) recommend to involve conspicuous enforcement at times and places with a lot of traffic but a small proportion of offenders (to create awareness) and unobtrusive controls at places and times with low traffic but a lot of offenders (to deter). Through media coverage about changes in enforcement practices and the effectiveness of enforcement strategies, the level of public awareness and, thus, the deterrence effect can be further enhanced (Krisman & Schöch, 2011).

Future dissemination should also explicitly address the consequences that are to expect in the case of offences due to illegal drugs because subjects are often not

aware of the different sanctioning stages according to the StVG[102], the StGB[103] and the FeV[104], respectively. A better knowledge about the consequences of breaking the law might enhance the deterrence effect of sanctions (Gelau & Pfafferott, 2009).

Better knowledge about laws and consequences of breaking the law, combined with scientifically-based information about why the law exists and what is pursued by adopting the law, enhances the general acceptance of the law, changes attitudes and fosters compliance to the law in question (Krisman & Schöch, 2011). So, media and educative measures are of great value for general deterrence as well as for general prevention measures (Krisman & Schöch, 2011).

As reported by Delaney, Lough, Whelan and Cameron (2004), pure information based and educative campaigns are not as effective as campaigns with a persuasive orientation and those that use emotional rather than rational appeals. Campaigns should address the personal needs of the recipient and should provoke emotions to increase the willingness of the recipient to deal with the safety topic in question. The present piece of work provides characteristics of persons at risk of driving under influence. From this knowledge, suggestions for designing prevention measures can be deduced.

16.4 Pros and Cons of the approach

What is the main difference between the German smartphone survey (GSS) compared to roadside surveys that are usually conducted to assess prevalence rates for drug driving? In the GSS, not the behaviour itself is the sample. Instead, the sample consists of different persons who reported their behaviour over a period of time. So, inter-individual variance is mixed with intra-individual variance.

The mixture of intra- and inter-individual variance enables combined evaluations that cannot be conducted if only the one or the other data source is available. Through the inter-individual variance, assumptions concerning the general frequency of the behaviour in question and general circumstances under which the behaviour occurs can be made. Because each person provided approximately the same amount of data (approximately 28 days), it is not mandatory that the data have to be averaged over persons when making such assumptions. But by averaging the behaviour on the individual level, person-related attributes can be compared. Furthermore, the intra-individual variance enables the evaluation of behavioural patterns and a more precise evaluation of motives behind the behaviour.

The generalisation from sample results to population parameters strongly depends on the way the study sample was composed. The via regia is random sampling, which best reproduces conditions within the general population. Because drug driving

[102] Straßenverkehrsgesetz: German Road Traffic Act.
[103] Strafgesetzbuch: German Penal Code.
[104] Fahrerlaubnisverordnung: German Driver Licensing Act.

is a rather seldom incidence, a sufficiently high number of subjects is crucial for generating reliable prevalence estimations. The number of subjects can be reduced if relevant factors for the behaviour under study can be identified and introduced as stratifying variables.

Therefore, a stratified sample with the factors age, gender and residence – variables that are thought to be confounders with respect to drug use and driving – was sought. By comparing the frequencies of the different values of the stratifying variables (males, females, 18-24-year-olds, 25-29-year-olds, 30-39-year-olds, subjects from rural, urban and city areas) within the sample with the corresponding proportions in the general German population that uses drugs and drives a vehicle regularly, a good representation of the population of interest through the study sample can be suggested. It was also shown that in terms of the consumed substances, the sample is comparable to the representative data provided by the ESA survey. By looking for mainly cannabis consuming subjects, a quasi-representative sample in terms of co-consumption could be established. The same accounts for the driving frequency that was found. The subjects' driving is nearly the same as the representative data (MiD 2008) suggest for the general population.

Two striking biases could be inherent on the subject level. Persons could have participated in the study as users in order to get the monetary reward without consuming drugs. Or they participated as controls while consuming drugs because they were worried about prosecution. Both biases can be denied by considering the results of the urine sample analysis, which was assessed randomly within the study period.

One simple source of error could be mistakes that were committed by the subjects when they reported their days. Again, no objective data can be provided to invalidate this criticism. But during data processing, several steps were taken to minimise errors: (1) subjects were given very detailed instructions, (2) subjects were trained on how to use the smartphone and to answer the daily questionnaire, (3) a system controlled consistency check for logical data inconsistencies, which were immediately announced by the system, was utilised and (4) a prompt person-controlled consistency check, which accounts for errors that only become obvious by considering the context of the current and surrounding situations, was performed. Furthermore, a good relationship was established between the subjects and the investigators within the study period. The subjects described the atmosphere as friendly and cooperative.

The greatest part of the data in the present report is based on self-reports. A person might for example say that the parents drink alcohol more than others do, even if this is, indeed, not true. Subjective data has to be interpreted with caution because several biases can be inherent. On the one hand, the subjects can consciously make false statements to conceal undesirable behaviour or attitudes (*Social desirability*). On the other hand, the subjects' statement itself can be biased because of a tendency to interpret circumstances in a way that lets them maintain a positive image of themselves (*Cognitive dissonance*; Festinger, 1957) or because of memory distor-

tions and biases in judging past experiences (Reuschenbach & Funke, 2011; Hufford et al., 2001).

The Traffic-specific item pool (VIP; Schmidt & Piringer, 1986), which was applied in the present survey, includes, among others, the control scale *Orientation at social expectations*. Only four subjects (1.4%) of all subjects who had a valid score on this scale reached far above-average values (one user, three controls), whereas a great part of subjects had far below-average values (61 subjects / 21.5%, 39 users / 21%, 22 controls / 22.4%). Even if the questionnaire refers to traffic-specific behaviour, high values can be a general indicator for a tendency to make social desired statements in questionnaire measures. Because only a few subjects reached high values and users were not more conspicuous than controls, a possible Social desirability bias can be neglected.

The subjects' perception might be biased with the function to reduce cognitive dissonance by only assuming that e.g. driving under influence is very common in general and that it poses no real risk (Festinger, 1957), whereas the reality proves to be different. Anyhow, according to Ajzen (1985), normative beliefs form the subjective norm referred to the behaviour in question. This subjective norm along with attitudes towards the behaviour and the perceived behavioural control has an impact on the occurrence of the behaviour. In the present context, the behaviour itself is especially of interest. The role of attitudes is of secondary importance. Of course, a connection between the social context and attitudes with deviant behaviour was shown, based on self-reports of the subjects. But if subjects indeed learn behaviour from social models or only think they would behave like other, close persons, is of minor interest. Either way, the findings indicate an influence of social perceptions and attitudes and should be considered in the context of prevention and rehabilitation, no matter how they developed.

With respect to memory distortion concerning the reports of the daily activities, it can be referred to Reuschenbach and Funke (2011) as well as Shiffman (2000) who claim that biases are less expected when episodic information (e.g. "How much alcohol did you drink at the last party?") has to be recalled as compared to global self-ratings (e.g. "How often do you usually drink alcohol"). In the present study, mainly episodic information was gathered by the daily reports.

Besides, a good correspondence could be demonstrated between the daily amount of alcohol consumption of the controls within the study and the general population, whereas users were found to drink more than the general population. Nothing can be stated about the representativeness of the consumption intensity of cannabis and all other substances as no representative data exist. Possible biases could be both an over- or underreporting of the amount of consumed drugs. Although no objective data can be provided to invalidate such assumptions, some crucial points should be mentioned. Most of the users participated in the study in order to contribute to a reasonable legislation concerning DUI, especially to driving under the influence of

cannabis[105]. Most cannabis users who took part feel victimised because of the harsh sanctions and strict regulations concerning driving after cannabis consumption. In their opinion, driving after alcohol consumption (above BAC 0.05%) is as dangerous as driving after cannabis consumption. But the prosecution when being caught under influence of cannabis is much harsher. Most users define this as a political decision to prohibit drug use in general. Through their participation in the study they wanted to foster scientifically based decision-making in policy. So, a massive underreporting of drug use or at least DUI could be the consequence of their motives. The rather high extent of cannabis consumption and DUI that was actually reported suggests that an underreporting is possible, indeed, but rather unlikely. Reasons for a systematic over-reporting of drug use or DUI are rare. Nevertheless, false statements about drug consumption and DUI cannot be entirely excluded.

Another well-known bias is the change of the behaviour just by the fact of being observed (i.e. reactive effect). Therefore, an analysis of (self-reported) former and current consumption was performed. Although the results are not very detailed, there is at least some indication that no massive change of behaviour took place. At the end of the survey, the subjects were also asked if their drug use and driving behaviour within the study period was comparable to their usual behavioural habits. The subjects in general stated no behavioural changes (no change of driving frequency: 99%, no change of consumption frequency: 94%). However, many subjects stated that they were rather surprised and became more aware of the real extent of their drug consumption by the daily reporting (18%) (a comparable effect by self-reports was found by Carels et al., 2004). One subject for example contacted the investigators several months after he had taken part in the study and mentioned that he had undergone a stay in hospital to treat his alcohol dependency. The hospital stay was initiated by the individual himself after he became aware of his risky drinking behaviour through the daily reports and through the counselling by the investigators at the end of the survey.

From the perspective of the authors, an undeniable constraint of the German smartphone survey is the estimation of substance blood levels in contrast to real measurements in body fluids. The BAC was estimated by the well-known Widmark formula (Widmark, 1932). THC levels were estimated by the elimination curve by Sticht (G. Sticht, personal communication, December 2009). For both estimation methods, assumptions had to be made about the exact point in time of consumption. It was decided to divide the amount of the reported substance intake within a longer period of time (e.g. 3 joints in 5 hours) evenly over all 15min periods within this time span, which of course can lead to incorrect estimations. In order to be as precise as possible, every modifying variable that was feasible to assess was taken into account (e.g. individual body weight, gender).

[105] This is known from the interviews with the subjects and can be seen in the comments in the guestbook on the study-website (www.doyoudrugdrive.de).

16.5 Final remarks

All in all, it seems that the new methodological approach that was implemented by the present study to estimate drug prevalences in the driving population does not have too many restrictions in comparison to the also complex design of roadside surveys. Through the present study, it was possible to create a database for not only quantifying the DUI prevalence but also for analysing surrounding conditions.

The advantages of the new methodological approach and the challenges with regards to the generalisation of the study results were already discussed. One objective of the present piece of work was the extrapolation of the frequency of drives under influence within the sample into representative values for the general German driver population. Except for these prevalence rates, all other reported findings refer to the population of regular drug users who regularly drive a vehicle compared to control subjects who do not use drugs but are comparable to the user sample with regards to age, gender and residence.

The results of the present study widen the view on drug driving and the associated circumstances. It was possible to emphasise different aspects of the problem and to integrate the information at a higher level. The model that was used is qualitative (Chapter 15). It shows dependencies that unfortunately cannot be exhaustively proved by the results because no causal relationship between the different variables can be drawn from the data inventory at hand. Further research is necessary to outline more precisely the connections derived in this report. But all in all, the intention of the study to put different aspects of drug driving (prevalence, situational and person-related predictors) into a broader context succeeded. The new methodological approach has proved to be a promising method and should serve as a standard to which future studies should aspire.

REFERENCES

Adriani, W., Caprioli, A., Granstrem, O., Carli, M. & Laviola, G. (2003). The spontaneously hypertensive-rat as an animal model of ADHD: Evidence for impulsive and non-impulsive subpopulations. *Neuroscience and Biobehavioral Reviews, 27*(7), 639-651.

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckman (Eds.), *Action-control: From cognition to behavior* (pp. 11-39). Heidelberg, Germany: Springer. Retrieved from http://people.umass.edu/aizen/ publications.html (01.08.2011).

Ajzen, I. & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Englewood: Prentice Hall.

Albery, I. P. & Guppy, A. (1995). Drivers' differential perceptions of legal and safe driving consumption. *Addiction, 90*, 245-254.

Albery, I. P., Strang, J., Gossop, M. & Griffiths, P. (2000). Illicit drugs and driving: Prevalence, beliefs and accident involvement among a cohort of current out-of-treatment drug users. *Drug and Alcohol Dependence, 58*, 197–204.

American Psychiatric Association (APA). (1994): *Diagnostic and statistical manual of mental disorders – DSM-IV*. Washington, DC: APA.

Armstrong, K., Wills, A. & Watson, B. (2005). *Psychosocial influences on drug driving in young Australian drivers.* Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Wellington, New Zealand.

Bahr, S. J., Hoffmann, J. P. & Yang, X. (2005). Parental and peer influences on the risk of adolescent drug use. *The Journal of Primary Prevention, 26*(6), 529-551.

Baldwin, W. (2000). Information no one else knows: The value of self-report. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report: Implications for research and practice* (pp. 3-8). Mahwah, NJ: Lawrence Erlbaum Associates.

Baumann, U., Feichtinger, L. & Thiele, C. (2001). Psychological monitoring in sociodiagnostics. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 45-68). Göttingen: Hogrefe & Huber Publishers.

Beauducel, A., Strobel, A. & Brocke, B. (2003). Psychometrische Eigenschaften und Normen einer deutschsprachigen Fassung der Sensation Seeking-Skalen, Form V. *Diagnostica, 49*(2), 61-72.

Berghaus, G. & Krüger, H.-P. (2007). Methoden epidemiologischer Forschung. In B. Madea, F. Mußhoff & G. Berghaus (Eds.), *Verkehrsmedizin: Fahreignung, Fahrsicherheit, Unfallrekonstruktion* (pp. 11-46). Köln: Deutscher Ärzte Verlag.

Bersoff D. M. & Bersoff, D. N. (2000). Ethical Issues in the collection of self-report data. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report: Implications for research and practice* (pp. 9-24). Mahwah, NJ: Lawrence Erlbaum Associates.

Borkenau, P. & Ostendorf, F. (1993). *NEO-Fünf-Faktoren Inventar (NEO-FFI), Handanweisung*. Göttingen: Hogrefe.

Bortz, J. & Döring, N. (2006). *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler* (4. Aufl.). Heidelberg: Springer.

Bortz, J. & Schuster, C. (2010). *Statistik für Human- und Sozialwissenschaftler* (7. Aufl.). Heidelberg: Springer.

Bukasa, B., Piringer, A. & Wenninger, U. (2003). *SENSO Test zur Erfassung der Sensomotorik, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B., Piringer, A. & Wenninger, U. (2004). *PVT Test zur Erfassung der peripheren Wahrnehmung bei gleichzeitiger Trackingaufgabe, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001a). *MAT Test zur Erfassung der nonverbalen Intelligenz, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001b). *Q1 Test zur Erfassung der Konzentrationsfähigkeit unter Monotonie, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001c). *LL5 Test zur Erfassung der visuellen Strukturierungsfähigkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001d). *GEMAT Test zur Erfassung der optischen Merkfähigkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Bukasa, B. & Wenninger, U. (2001e). *RST3 Test zur Erfassung der reaktiven Belastbarkeit, Manual*. Wien: Kuratorium für Verkehrssicherheit.

Burger, M., Bronstrup, A. & Pietrzik, K. (2004). Derivation of tolerable upper alcohol intake levels in Germany: A systematic review of risks and benefits of moderate alcohol consumption. *Preventive Medicine, 39*(1), 111–27.

Buse, L. & Pawlik, K. (2001). Computer-assisted Ambulatory assessment performance tests in everyday situations: Construction, evaluation, and psychometrik properties of a test battery measuring mental activation. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 45-68). Göttingen: Hogrefe & Huber Publishers.

Carels, R. A., Douglass, O. M., Cacciapaglia, H. M. & O'Brien, W. H. (2004). An ecological momentary assessment of relapse crises in dieting. *Journal of Consulting and Clinical Psychology, 72*(2), 341-348.

Caspi, A., Begg, D., Dickson, N., Harrington, H., Langley, J., Moffitt, T. E. et al. (1997). Personality differences predict health-risk behaviors in young adulthood: Evidence from a longitudinal study. *Journal of Personality and Social Psychology, 73*(5), 1052-1063.

Castella, J. & Perez, J. (2004). Sensitivity to punishment and sensitivity to reward and traffic violations. *Accident Analysis & Prevention, 36*(6), 947-952.

Conover, W. J. & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician, 35*, 124-129.

Cook, R. F., Bernstein, A. D. & Andrews, C. M. (1997). Assessing drug use in the workplace: A comparison of self-report, urinalysis, and hair analysis. In L. Harrison and A. Hughes (Eds.), *The validity of self-reported drug use: Improving the* accuracy *of survey estimates.* NIDA Research Monograph, 167, 247-272.

Costa, P. T. & McCrae, R. R. (1985). *The NEO personality inventory manual*. Odessa, FL: Psychological Assessment Resources.

Cruise, C. E., Broderick, J., Porter, L., Kaell, A. & Stone, A. A. (1996). Reactive effects of diary self-assessment in chronic pain patients. *Pain, 67*, 253-258.

Darke, S., Kelly, E. & Ross, J. (2004). Drug driving among injecting drug users in Sydney, Australia: Prevalence, risk factors and risk perceptions. *Addiction, 99*(2), 175-185.

Davey, J. D., Davey, T. & Obst, P. L.. (2005). Drug and drink driving by university students: An exploration of the influence of attitudes. *Traffic Injury Prevention, 6*(1), 44 – 52.

Delaney, A., Lough, B., Whelan, M. & Cameron, M. (2004). *A review of mass media campaigns in road safety.* Melbourne: Monash University Accident Research Centre. Retrieved from http://www.monash.edu.au/muarc/reports/muarc220.pdf (01.08.2011).

Deutsche Shell (2000). *Jugend 2000 – 13. Shell Jugendstudie.* Opladen: Leske + Budrich.

Destatis (2011a). *Verkehrsunfälle - Zeitreihen – 2010*. Retrieved from https://www.destatis.de/DE/Publikationen/Thematisch/TransportVerkehr/Verkehrsunfaelle/VerkehrsunfaelleZeitreihen.html?nn=68810) (17.05.2012).

Destatis (2011b). *Statistical Yearbook 2009 – For the Federal Republic of Germany*. Statistisches Bundesamt (Federal Statistical Office). Wiesbaden. Retrieved from https://www.destatis.de/DE/Publikationen/StatistischesJahrbuch/Jahrbuch2009.pdf?__blob=publicationFile) (17.05.2012).

Di Franco, D. (2007). *Eine empirische Studie zur subjektiven Gesundheitssituation der Studierenden* (Master's thesis). Retrieved from http://www.gesundheitsfoerdernde-hochschulen.de/Inhalte/ F_Gesundheitssurvey_NRW/Diplomarbeit%20Frau%20DiFranco.pdf (01.05.2012).

Donovan, D. M., Marlatt, G. A. & Salzberg, P. M. (1983). Drinking behavior, personality factors and high-risk driving. A review and theoretical formulation. *Journal of Studies on Alcohol, 44*(3), 395-428.

Erdmann, G. & Janke, W. (2008). *Stressverarbeitungsfragebogenn / Stress, Stressverarbeitung und ihre Erfassung durch ein mehrdimensionales Testsystem* (4. überarb. und erw. Aufl.). Göttingen: Hogrefe.

European Transport Safety Council (ETSC). (1999). *Police enforcement strategies to reduce traffic casualties in Europe*. ETSC, Brussels.

Fahrenberg, J. (1996). Ambulatory assessment: Issues and perspectives. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 3-20). Göttingen: Hogrefe & Huber Publishers.

Fahrenberg, J., Hüttner, P. & Leonhart, R. (2001). *MONITOR:* Acquisition of psychological data by a hand-held PC. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 93-112). Göttingen: Hogrefe & Huber Publishers.

Fahrenberg, J., Myrtek, M., Pawlik, K. & Perrez, M. (2007). Ambulatory assessment – Verhalten im Alltagskontext erfassen. *Psychologische Rundschau, 58*(1), 12–23.

Federal Motor Transport Authority (2004): *Jahresbericht 2004*. Retrieved from http://www.kba.de/cln_005/nn_124834/DE/Presse/Jahresberichte/jahresbericht__2004__pdf,templateId=raw,property=publicationFile.pdf/jahresbericht_2004_pdf.pdf (17.05.2012).

Federal Motor Transport Authority (2009): *Jahresbericht 2009*. Retrieved from http://www.kba.de/cln_005/nn_124834/DE/Presse/Jahresberichte/jahresbericht__2009__pdf,templateId=raw,property=publicationFile.pdf/jahresbericht_2009_pdf.pdf (17.05.2012).

Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.

Gelau, C. & Pfafferott, I. (2009). Verhaltensbeeinflussung durch Sicherheitskommunikation und Verkehrsüberwachung. In H.-P. Krüger (Ed.), *Enzyklopädie der Psychologie: Praxisgebiete / Verkehrspsychologie. Volume 2: Anwendungsfelder der Verkehrspsychologie* (pp. 81-126). Göttingen: Hogrefe.

Gray, J. A. (1972). The psychophysiological basis of introversion-extraversion: A modification of Eysenck's theory. In V. D. Nebylitsyn & J. A. Gray (Eds.), *The biological basis of individual behavior*. New York: Academic.

Gray, J. A. (1981). A critique of Eysenck's theory of personality. In H. J. Eysenck (Ed.), *A model for personality*. Berlin: Springer

Hargutt, V., Krüger, H.-P. & Knoche, A. (2011). *Driving under the influence of alcohol, illicit drugs and medicines. Risk estimations from different methodological approaches*. DRUID project deliverable 1.3.1. Retrieved from http://www.druid-project.eu (01.05.2012).

Harris, K. B. & Miller, W. R. (1990). Behavioral self-control training for problem drinkers: Components of efficacy. *Psychology or Addictive Behavior, 4*(2), 82-90.

Harrison, L. (1997). The validity of self-reported drug use in survey research: An overview and critique of research methods. In L. Harrison and A. Hughes (Eds.), *The validity of self-reported drug use: Improving the accuracy of survey estimates.* NIDA Research Monograph, 167, 17-36.

Harrison, L. & Hughes, A. (1997). Introduction – The validity of self-reported drug use: Improving the accuracy of survey estimates. In L. Harrison & A. Hughes (Eds.), *The validity of self-reported drug use: Improving the accuracy of survey estimates.* NIDA Research Monograph, 167, 1-16.

Helbig, S., Lang, T., Swendsen, J., Hoyer, J. & Wittchen, H.-U. (2009). Implementierung, Akzeptanz und Informationsgehalt eines Ecological Momentary Assessment (EMA)-Ansatzes bei Patienten mit Panikstörung und Agoraphobie. *Zeitschrift für Klinische Psychologie und Psychotherapie, 38*(2), 108-117.

Houwing, S., Hagenzieker, M., Mathijssen, R., Bernhoft, I. M., Hels, T., Janstrup, K. et al. (2011a). *Prevalence of alcohol and other psychoactive substances in drivers in general traffic Part I: General results*. DRUID project deliverable 2.2.3 I. Retrieved from http://www.druid-project.eu (01.05.2012).

Houwing, S., Hagenzieker, M., Mathijssen, R., Bernhoft, I. M., Hels, T., Janstrup, K. et al. (2011b). *Prevalence of alcohol and other psychoactive substances in drivers in general traffic Part II: Country reports*. DRUID project deliverable 2.2.3 II. Retrieved from http://www.druid-project.eu (01.05.2012).

Hoyt, M. F., 1973. Internal-external control and beliefs about automobile travel. *Journal of Research in Personality, 7*, 288-293.

Hufford, M. R., Shiffman, S., Paty, J. & Stone, A. A. (2001). Electronic momentary assessment: Real-world, real-time measurement of patient experience. In J. Fahrenberg & M. Myrtek (Eds.), *Progress in ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 69-92). Göttingen: Hogrefe.

Janker, H. (Ed.). (2009). *Straßenverkehrsrecht (StVR). Beck-Texte* (49th ed.). München: Deutscher Taschenbuch Verlag.

Jobe, J. B. (2000). Cognitive processes in self-report. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report: Implications for research and practice* (pp. 25-28). Mahwah, NJ: Lawrence Erlbaum Associates.

Jonah, B. A. (1997). Sensation seeking and risky driving: A review and synthesis of the literature. *Accident Analysis and Prevention, 29*(5), 651-665.

Kaplan, H. B. (1975): *Self-attitudes and deviant behavior*. Pacific Palisades, CA: Goodyear.

Karjalainen, K., Lintonen, T., Impinen, A., Lillsunde, P., Mäkelä, M., Rahkonen, O. et al. (2011). Socio-economic determinants of drugged driving – A register-based study. *Addiction, 106*, 1448–1459.

Kelly, E., Darke, S., Ross, J. (2004). A review of drug use and driving: epidemiology, impairment, risk factors and risk perceptions. *Drug and Alcohol Review, 23*(3), 319-344.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R. & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*, 593-602.

Krampen, G. (1981). *IPC-Fragebogen zu Kontrollüberzeugungen („Locus of Control"), Handanweisung*. Göttingen: Hogrefe.

Kraus, L., Pfeiffer-Gerschel, T. & Pabst, A. (2006). Cannabis und andere illegale Drogen: Prävalenz, Konsummuster und Trends. Ergebnisse des Epidemiologischen Suchtsurveys 2006. *Sucht, 54*(S1), 16-25.

Krismann, M. & K.-H. Schöch (2011). *Evaluation of legal measures to combat DUI / DUID*. DRUID Project Deliverable 1.4.1. Retrieved from http://www.druid-project.eu (01.08.2011).

Krüger, H.-P., Schulz, E. & Magerl, H. (1996). *Medikamenten- und Drogennachweis bei verkehrsunauffälligen Fahrern – Roadside Survey*. Berichte der Bundesanstalt für Straßenwesen, M 60. Bremerhaven: Wirtschaftsverlag NW.

Krüger, H.-P. & Vollrath, M. (2009). Psychotrope Substanzen im Straßenverkehr. In H.-P. Krüger (Ed.), *Enzyklopädie der Psychologie: Praxisgebiete / Verkehrspsychologie. Volume 2: Anwendungsfelder der Verkehrspsychologie* (pp. 441-466). Göttingen: Hogrefe.

Lapham, S. C., Smith, E., de Baca, J. C., Chang, I., Skipper, B. J., Baum, G. et al. (2001). Prevalence of psychiatric disorders among persons convicted of driving while impaired. *Archives of General Psychiatry, 58*(10), 943-949.

Lessler, J. T. & O'Reilly, J. M. O. (1997). Mode of interview and reporting of sensitive issues: Design and implementation of audio computer-assisted self-interviewing. In L. Harrison & A. Hughes (Eds.), *The validity of self-reported drug use: Improving the accuracy of survey estimates.* NIDA Research Monograph, 167, 366-382.

Lewrenz, H.. (2000). *Begutachtungs-Leitlinien zur Kraftfahrereignung*. Berichte der Bundesanstalt für Straßenwesen, M 115. Bremerhaven: Wirtschaftsverlag NW.

Madea, B. & Dettmeyer, R. (2007). *Basiswissen Rechtsmedizin*. Heidelberg: Springer.

Mc Guire, F., Dawe, M., Shield, K. D., Rehm, J. & Fischer, B. (2011). Driving under the influence of cannabis or alcohol in a cohort of high-frequency cannabis users: Prevalence and reflections on current interventions. *Canadian Journal of Criminology and Criminal Justice, 53*(2), 247-259.

Meyer, C., Rumpf, H. J., Hapke, U., Dilling, H. & John, U. (2000). Lebenszeitprävalenz psychischer Störungen in der erwachsenen Allgemeinbevölkerung – Ergebnisse der TACOS-Studie. *Der Nervenarzt*, *71*(7), 535-542.

Miller, D. K. & Blum, K. (1996). *Overload: Attention deficit disorder and the addictive brain.* Kansas City: Andrews McMeel.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M. & Swann, A. C. (2001). Psychiatric aspects of impulsivity. *The American Journal of Psychiatry, 158*(11), 1783-1793.

Müller, C. P., Topic, B., Huston, J. P., Strohbeck-Kühner, P., Lutz, B., Skopp, G. et al. (2006). *Cannabis und Verkehrssicherheit*. Berichte der Bundesanstalt für Straßenwesen, M 182. Bremerhaven: Wirtschaftsverlag NW.

Nelson, R. O. & Hayes, S. C. (1981). Theoretical explanations for reactivity in self-monitoring. *Behavior Modification, 5*(3), 3-14.

Pabst, A. & Kraus, L. (2006). Alkoholkonsum, alkoholbezogene Störungen und Trends. Ergebnisse des Epidemiologischen Suchtsurveys 2006. *Sucht, 54*(S1), 16-25.

Passie, T., Seifert, J., Schneider, U. & Emrich, H. M. (2002). The pharmacology of psilocybin. *Addiction Biology, 7*(4), 357-364.

Perrez, M., Wilhelm, P., Schoebi, D. & Horner, M. (2001). Simultaneous computer-assisted assessment of causal attribution and social coping in families. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 45-68). Göttingen: Hogrefe & Huber Publishers.

Peters, M. L., Sorbi, M. J., Kruise, D. A., Kerssens, J. J., Verhaak, P. F. M. & Bensing, J. M. (2000). Electronic diary assessment of pain, disability and psychological adaptation in patients differing in duration of pain. *Pain, 84*, 181-192.

Prisinzano, T. E. (2005). Psychopharmacology of the hallucinogenic sage Salvia divinorum. *Life Sciences, 78*(5), 527-531.

Reuschenbach, B. (2006). Ecological momentary assessment (EMA): Anwendungen und Perspektiven in der Pflegewissenschaft. *Zeitschrift für Pflege- und Gesundheitswissenschaft*, *2006*(9), 487-496. Retrieved from http://www.pflege-wissenschaft.info/artikel/648 (06.05.2012).

Reuschenbach, B. & Funke, J. (2011). Ambulantes Assessment. In L. Hornke, M. Amelang & M. Kersting (Eds.), *Enzyklopädie der Psychologie: Methodologie und Methoden* / Psychologische Diagnostik*. Volume 3: Leistungs-, Intelligenz- und Verhaltensdiagnostik* (pp. 528-594). Göttingen: Hogrefe.

Rotter, J. (1966). Generalized expectancies for internal versus external control of reinforcements, *Psychological Monographs*, *80*, whole no. 609.

Ryb, G. E., Dischinger, P. C., Kufera, J. A. & Read, K. M. (2006). Risk perception and impulsivity: Association with risky behaviors and substance abuse disorders. *Accident Analysis and Prevention, 38*(3), 567-573.

Schmidt, L. & Piringer, A. (1986). *VIP Verkehrsspezifischer Itempool. Testhandbuch*. Wien: Kuratorium für Verkehrssicherheit.

Schroder, K. E. E. & Perrine, M. W. (2007). Covariations of emotional states and alcohol consumption: Evidence from 2 years of daily data collection. *Social Science & Medicine, 65*(12), 2588-2602.

Schulz, M. & Schmoldt, A. (2003). Therapeutic and toxic blood concentrations of more than 800 drugs and other xenobiotics. *Pharmazie, 58*(7), 447-474.

Schwartz, J. E. & Stone, A. A. (1998). Strategies for analyzing ecological momentary assessment data. *Health psychology, 17*, 6-16.

Searles, J. S., Perrine, M. W., Mundt, J. C. & Helzer, J. E. (1995). Self-report of drinking using touch-tone telephone: Extending the limits of reliable daily contact. *Journal of Studies on Alcohol, 65*(4), 375-382.

Shaffer, H. J., Nelson, S. E., LaPlante, D. A., LaBrie, R. A., Albanese, M. & Caro, G. (2007). The epidemiology of psychiatric disorders among repeat DUI offenders accepting a treatment-sentencing option. *Journal of Consulting and Clinical Psychology, 75*(5), 795-804.

Sherman, M. F. & Bigelow G. E. (1992). Validity of patients' self-reported drug use as a function of treatment status. *Drug and Alcohol Dependence, 30*, 1-11.

Shiffman, S. (2000). Real-time self-report of momentary states in the natural environment: Computerized ecological momentary assessment. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman & V. S. Cain (Eds.), *The science of self-report: Implications for research and practice* (pp. 277-296). Mahwah, NJ: Lawrence Erlbaum Associates.

Swann, A. C., Bjork, J. M., Moeller, F. G. & Dougherty, D. M. (2002). Two models of impulsivity: Relationship to personality traits and psychopathology. *Biological Psychiatry, 51*(12), 988-994.

Tellegen, A. (1982). *Brief manual of the multidimensional personality questionnaire*. Unpublished manuscript. University of Minnesota.

Tensil, M.-D., Strüber, E. (2010). Suchtprävention im Internet am Beispiel von www.drugcom.de. *e-beratungsjournal.net, 6*(1), 1-13. Retrieved from http://www.e-beratungsjournal.net/ausgabe_0110/tensil.pdf (06.05.2012).

Thomas, J. R., Nelson, J. K. & Thomas, K. T. (1999). A generalized rank-order method for nonparametric analysis of data from exercise science: A tutorial. *Research Quarterly for Exercise and Sport, 70*(1), 11-23.

Torrubia, R., Ávila, C., Moltó, J. & Caseras, X. (2001). The sensitivity to punishment and sensitivity to reward questionnaire (SPSRQ) as a measure of Gray's anxiety and impulsivity dimensions. *Personality and Individual Differences, 31*(6), 837-862.

Turkkan, J. S. (2000). General issues in self-report. In A. A. Stone, J. S. Turkkan, C. A. Bachrach, J. B. Jobe, H. S. Kurtzman, V. S. Cain (Eds.), *The science of self-report: Implications for research and practice* (pp. 1-2). Mahwah, NJ: Lawrence Erlbaum Associates.

Ullrich, R. & Ullrich, R. (1998). *Das Assertiveness-Training-Programme ATP: Einübung von Selbstvertrauen und sozialer Kompetenz, Anleitung für den Therapeuten, Teil II. Der Unsicherheitsfragebogen, Testmappe U*. München: Pfeiffer.

Vollrath, M., Löbmann, R., Krüger, H.-P., Schöch, H., Widera, T. & Mettke, M. (2001). Fahrten unter Drogeneinfluss – Einflussfaktoren und Gefährdungspotenzial. Berichte der Bundesanstalt für Straßenwesen, M 132. Bremerhaven: Wirtschaftsverlag NW.

Vorndran, I (2009). Unfallentwicklung auf deutschen Straßen 2008. *Wirtschaft und Statistik 7/2009*, 697-710. Retrieved from https://www.destatis.de/DE/Publikationen/WirtschaftStatistik/Monatsausgaben/WistaJuli09.pdf?__blob=publicationFile (17.05.2012).

Walter, M., Hargutt, V. & Krüger, H.-P. (2011a). *German smartphone survey Part I: Prevalence of psychoactive substances and consumption patterns in traffic, based on a smartphone survey in Germany*. DRUID project deliverable 2.2.2 I. Retrieved from http://www.druid-project.eu (17.05.2012).

Walter, M., Hargutt, V. & Krüger, H.-P. (2011b). *German smartphone survey Part II: Person-related characteristics of drug users and drug drivers compared to controls*. DRUID project deliverable 2.2.2 II. Retrieved from http://www.druid-project.eu (17.05.2012).

Watling, C. N., Palk, G. R., Freeman, J. E. & Davey, J. D. (2009). Applying Stafford and Warr's reconceptualization of deterrence theory to drug driving: Can it predict those likely to offend?. *Accident Analysis and Prevention, 42*, 452-458.

Wheeler, L. & Reis, H. T. (1991). Self-recording of everyday life events: Origins, types, and uses. *Journal of Personality, 59*(3), 339-354.

Widera, T. K. (2003). Alkohol und Drogen im Straßenverkehr – Eine inhaltsanalytische Studie. (Doctoral dissertation). Berlin: dissertation.de – Verlag im Internet GmbH.

Widmark, E. M. (1932). *Die theoretischen Grundlagen und die praktische Verwendbarkeit der gerichtlich-medizinischen Alkoholbestimmung*. Berlin: Urban & Schwarzenberg.

Wilhelm, P. (2001). A multilevel approach to analyze ambulatory assessment data: An examination of family members' emotional states in daily life. In J. Fahrenberg & M. Myrtek (Eds.), *Ambulatory assessment: Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 173-189). Göttingen: Hogrefe & Huber Publishers.

Wilhelm, P. & Perrez, M. (2001). Felddiagnostik. In R.-D. Stieglitz, U. Baumann & H. J. Freyberger (Eds.), *Psychodiagnostik in Klinischer Psychologie, Psychiatrie, Psychotherapie* (pp. 169-182). Stuttgart: Thieme.

Wittchen, H.-U., Zaudig, M. & Fydrich, T. (1997). *SKID – Strukturiertes Klinisches Interview für DSM-IV Achse I und II, Handanweisung*. Göttingen: Hogrefe.

Zaal, D. (1994). *Traffic law enforcement: A review of the literature* (Report No. 53). Melbourne: Monash University Accident Research Centre.

Zeberlein, K. & Küfner, H. (2003). Deutsche Version des Attention Deficit and Hyperactivity Disorders Fragebogens. Ergebnisse einer psychometrischen Analyse. In A. Glöckner-Rist, F. Rist & H.

Küfner (Eds.), *Elektronisches Handbuch zu Erhebungsinstrumenten im Suchtbereich (EHES)*. Version 3.00. Mannheim: Zentrum für Umfragen, Methoden und Analysen.

Zuckerman, M., Eysenck, S. B. & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology, 46*(1) 139-149.

ANNEX

17.1 Description of the website

In the following, the main sections of the website that was developed and launched within the frame of the study are briefly described (http://www.doyoudrugdrive.de / http://www.DYDD.de):

- *Info*: Information for potential participants about the background, the main objectives, the aim and the conducting institution of the study.
- *Study:* Inclusion criteria (age, consumption and driving habits), registration procedure, necessary effort, incentives and privacy of the data.
- *Smartphone*: Introduction of the smartphone as main research instrument and short exemplary section of the questionnaire.
- *News:* Update regarding important project steps.
- *Visitor's book*: Feedback from former participants.
- *Press*: Contact details, existing press reports about the study.
- *Contact:* Contact details.
- *FAQ*: Most asked questions about data protection, privacy and prosecution.
- *Links:* Information about further research in this area, drug information services and advisory services.

Figure 129: Abstract of the doyoudrugdrive-website.

17.2 Q-Start-Questionnaire

Center for Traffic Sciences at the University of Würzburg IZVW

VpID: _____ date: _____

code: _____

Dear participant,

thank you for agreeing to participate in our study.

As an institute for traffic sciences we want to figure out by this examination, if people who take drugs even drive on drugs.

Below, you will find a set of questions regarding your driving experience as well as your drug experience (controls: if any). Please, read the questions carefully and attend especially to the bold passages. The questionnaire will be introduced by questions concerning your person.

Of course, we treat your statements as strictly confidential and anonymous. Please register the **date and month of birth of your mother** and **your year of birth** in the domain „code" in the top margin on the right.

Example: date of birth of your mother: **20.03**.1948 / own date of birth: 07.05.19**78**
code: **200378**

There is no right or wrong in your answers, and you don't have to be an expert for answering the questions. You serve the study's purpose best, if you answer as honestly as possible, i.e. in an appropriate way for you personnally. Please respond to the questions swiftly but carefully and preferably attend to all questions.

Q-Start 1

Figure 130: Q-Start-Questionnaire about sociodemographic attributes, driving and drug use experience, previous drug driving, corresponding peer behaviour and attitudes.

PERSONAL INFORMATION

(1) Your gender: ❍ male ❍ female

(2) How old are you? _____ years

(3) What is your nationality? _____

(4) Your marital status:

- ❍ single
- ❍ married
- ❍ have been married (divorced, widowed)

(5) Who do you live with permanently?

- ❍ alone
- ❍ with partner and ____ children
- ❍ without partner and ____ children
- ❍ in a flat-sharing community (number of flat mates, you included: ____)
- ❍ in residential home
- ❍ with parents/relatives
- ❍ with parents/relatives, but in own flat

(6) What is your highest level of **general** education completed?

- ❍ left school without degree
- ❍ (Hauptschulabschluss)
- ❍ GCSE (General Certificate of Secondary Education)
- ❍ vocational diploma (Fachhochschulreife)
- ❍ A-Level
- ❍ other degree _____
- ❍ still student

(7) Your highest **professional** education completed:

- ❍ skilled worker (Teilfacharbeiter)
- ❍ apprenticeship (Abschluss einer beruflich-betrieblichen Berufsausbildung (Lehre))
- ❍ vocational school (Abschluss einer beruflich-schulischen Ausbildung (Berufsfach-/ Handelsschule))
- ❍ masterschool, technical school (Abschluss an einer Fachschule, Meister- oder Technikerschule, Berufs- oder Fachakademie)
- ❍ university of applied sciences (Fachhochschulabschluss)
- ❍ university (Hochschulabschluss)
- ❍ conferral of a doctorate (Promotion)
- ❍ other degree _____
- ❍ no degree
- ❍ still in apprenticeship/studies (noch in der Ausbildung/im Studium/Schüler(in))

(8) What applies to you at present?
(*Please, just check <u>one</u>!*)

- ❍ full time employed
- ❍ part time employed (15 to max. 35 hours a week)
- ❍ marginal employed (under 15 hours a week)
- ❍ apprentice
- ❍ scholar
- ❍ student (branch of study: _____)
- ❍ currently unemployed
- ❍ temporarily released (e.g. maternity-/ childcare leave)
- ❍ house wife / -husband
- ❍ pensioner
- ❍ conscript / alternative civilian service
- ❍ other _____

(9) Which occupation do you have at present or did you have at last?
(*Please, just check one!*)

- ❍ worker
- ❍ clerk in simple occupation (e.g. shop assistant)
- ❍ clerk in qualified occupation (e.g. administrator, accountant, draughtsman)
- ❍ clerk in highly qualified occupation (university graduate)
- ❍ clerk in administrative function (e.g. director, executive, manager of bigger enterprises and organizations)
- ❍ civil servant in the lower grade of the civil service
- ❍ civil servant in the middle grade of the civil service
- ❍ civil servant in the upper grade of the civil service
- ❍ civil servant in the higher grade of the civil service
- ❍ independet graduate (e.g. medic, advocate, tax consultant) / artist
- ❍ independent in trade, business, services, industry
- ❍ independent agriculturist
- ❍ working for a family member
- ❍ other _____

(10) If you are employed, which job do you have at present? _____

(11) Are you working in your free time to earn money? ❍ yes ❍ no

(12) How large is the city you live in?

- ❍ less than 2,000 inhabitants
- ❍ 2,000-5,000 inhabitants
- ❍ 5,000-20,000 inhabitants
- ❍ 20,000-50,000 inhabitants
- ❍ 50,000-100,000 inhabitants
- ❍ 100,000-500,000 inhabitants
- ❍ more than 500,000 inhabitants
- ❍ I don't know, I live in _____

(13) What's your **net income** you have at your disposal per month (including scholarship, housing subsidy, financial support from parents)

- ❍ less than 500 euros
- ❍ 500-1,000 euros
- ❍ 1,000-1,500 euros
- ❍ 1,500-2,000 euros
- ❍ 2,000-2,500 euros
- ❍ more than 2,500 euros

(14) How would you assess your general state of health?

very bad 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 very well

(15) Do you suffer from a chronic disease (e.g. rheumatism, diabetes, thyroid diseases...)? Or were you diagnosed with ADHD?

- ❍ yes, which? _____
- ❍ no

(16) How much do you weigh? _____ kg

(17) If you take medication regularly, please list the exact names of the medication, the dosage and how long you have been taking it.

Name of medication	Dose (morning-midday-evening)	Intake since (month/year)
	O if required	
	O if required	

DRIVING EXPERIENCE

(18) For which type of vehicle do you have a driving licence? How many years ago did you get it?

- ❍ motor-assisted bicycle /moped since (year) _____
- ❍ motorbike since (year) _____
- ❍ car since (year) _____
- ❍ truck since (year) _____

(19) Do you have your driving licence probationary? ❍ yes ❍ no

(20) Which of the following vehicles do you own?

- ❍ motor-assisted bicycle /moped
- ❍ motorbike
- ❍ car
- ❍ none

(21) How often do you have your car available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(22) How often are you the driver of the car?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(23) If you drive a moped or motorbike: How often do you have it available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(24) If you drive a moped or motorbike: How often are you the driver?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(25) If you have a truck driver's licence: How often do you have the truck available?

- ❍ anytime
- ❍ occasionally
- ❍ very seldom
- ❍ not at all

(26) If you have a truck driver's licence: How often are you the driver?

- ❍ almost every day
- ❍ 1-3 times per week
- ❍ 1-3 times per month
- ❍ very seldom
- ❍ (almost) not at all

(27) What is the public transport connection from your home to your ordinary destinations like?

don't know	very good	good	to some extent	bad	very bad
0	1	2	3	4	5

(28) How many kilometres do you drive per year as the driver of a car?

- ❍ up to 4,999 km
- ❍ 5,000 to 9,999 km
- ❍ 10,000 to 14,999 km
- ❍ 15,000 to 19,999 km
- ❍ 20,000 to 29,999 km
- ❍ 30,000 km and more
- ❍ didn't drive last year

(29) How many kilometres have you driven since you got your driving licence?

- ❍ less than 10,000 km
- ❍ 10,000 to 50,000 km
- ❍ 50,000 to 100,000 km
- ❍ 100,000 to 300,000 km
- ❍ more than 300,000 km

(30) How essential is your driving licence to your private life (work excluded)?

I don't need it 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 I can't get along without

(31) How essential is your driving licence to your profession (including drive to work)?

I don't need it 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 without it I can't do my job

(32) Does your profession include driving a motor vehicle (driving to and return from work is not meant!)?

❍ yes ❍ no

(33) Do you have part time jobs, which entail driving a motor vehicle?

❍ yes ❍ no

(34) In general, do you prefer to be the driver or passenger?

- ❍ driver
- ❍ passenger
- ❍ I have no preference

(35) How much do you like driving the car you most often use?

very much	much	medium	little	very little
1	2	3	4	5

(36) How do you rate your current driving skills?

very good	good	medium	bad	very bad
1	2	3	4	5

(37) Which motor vehicle do you drive most often at present?

brand / type: _____ year of construction: _____

motor capacity: _____ ○ kW ○ hp (please mark)

(38) Have you ever gotten points in the Central Register of Traffic Offenders?

❍ yes occasion(s): _____

❍ no

(39) How many points do you approximately have at the Central Register of Traffic Offenders at present?

_____ points

(40) Was your driving licence ever revoked?

_____ times occasion(s): _____

(41) Have you ever got a parking ticket?

❍ yes, how many times approx.? _____ ❍ no

(42) How dangerous is driving by car in your opinion?

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(43) What are in your opinion the three most important causes of traffic accidents? Please, name the most important first, the second-important next and the third-important last. Rate additionally, how dangerous the cause is in your opinion.

1st cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

2nd cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

3rd cause of accident: _____

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(44) If you haven't already named alcohol in the previous question, please rate how dangerous drink-driving is as a cause of accidents in your opinion.

absolutely safe 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 extremely dangerous

(45) Even if you have named illegal drugs in the previous question, please rate in more detail how dangerous the following drugs on driving are as a cause of traffic accidents.

	absolutely safe extremely dangerous
cannabis	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
stimulants (e.g. amph.,speed)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
ecstasy	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
hallucinogens (e.g. LSD, mushrooms)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
cocaine	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
opiates (heroin and others)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
tranquillizers	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10

ACCIDENT EXPERIENCE

(46) How many accidents were you involved in as driver?

in ____ accidents

Please describe briefly the accident(s) below. If you were involved in more than three accidents, please describe the last three.

accident No 1: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

accident No 2: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

accident No 3: _____

_____

_____

time (month / year): _____

injury to persons:	❍ yes	❍ no	
negligence:	❍ personal	❍ third party	❍ contributary
field sobriety test by police:	❍ yes	❍ no	
under the influence of alcohol:	❍ myself	❍ the other	❍ none
drug test by police:	❍ yes	❍ no	
under the influence of drugs:	❍ myself	❍ the other	❍ none
accident registered by police:	❍ yes	❍ no	

DRUG EXPERIENCE

(47) Do you currently smoke or did you smoke in the past?

- ❍ yes, I am smoker (started at the age of ___)
- ❍ yes, I have smoked in the past (at the age of ___ till ___)
- ❍ no, I am non-smoker and never smoked in the past

(48) If yes, how many cigarettes do you smoke per day or did you smoke per day?

- ❍ less than 5
- ❍ 5-9
- ❍ 10-17
- ❍ 1 packet
- ❍ 2 packets
- ❍ more than 2 packets

(49) Have you ever taken any of the following drugs (incl. alcohol)? If yes, when was the first time? How many years ago?

- ❍ alcohol: ___ years ago
- ❍ cannabis (hemp, marihuana, weed): ___ years ago
- ❍ (meth-)amphetamines/speed: ___ years ago
- ❍ ecstasy: ___ years ago
- ❍ LSD: ___ years ago
- ❍ mushrooms: ___ years ago
- ❍ cocaine: ___ years ago
- ❍ crack: ___ years ago
- ❍ heroin: ___ years ago
- ❍ sniffing: ___ years ago
- ❍ other: _____ ___ years ago

(50) Which of the following drugs would you never take or would you never take again?

- ❍ alcohol
- ❍ cannabis (hemp, marihuana, weed)
- ❍ (meth-)amphetamines/speed
- ❍ ecstasy
- ❍ LSD
- ❍ mushrooms
- ❍ cocaine
- ❍ crack
- ❍ heroin
- ❍ sniffing
- ❍ other: _____

- ❍ I would take all of these substances.

(51) User: How would you describe the effects of the drugs you have taken (question 49)? (examples → see next page)

- ❍ alcohol (BAC<0.05%): _____
  (BAC>0.05%): _____
- ❍ cannabis: _____
- ❍ (meth-)amphetamines/speed: _____
- ❍ ecstasy: _____
- ❍ LSD: _____
- ❍ mushrooms: _____
- ❍ cocaine: _____
- ❍ crack: _____
- ❍ heroin: _____
- ❍ sniffing: _____
- ❍ other: _____ _____

examples: stimulating, performance-enhancing, intensifies emotions, euphoriant, anxiolytic, relaxing, sedative, dulling, flustering, leeds to psychoses, leeds to overestimation of one's own capabilities, leeds to depressive moods

(52) From the first time to this day, how often have you taken the following drugs?

	never	1x	2x	3-5x	6-9x	10-39x	≥ 40x
cannabis							
(meth-)amphetamines/speed							
ecstasy							
LSD							
mushrooms							
cocaine							
crack							
heroin							
sniffing							
other: _____							

(53) How long has it been since you have taken the following drugs for the last time?

	< 1 month	1-5 months	6-11 months	≥ 12 months	≥ 2 years	≥ 5 years	never consumed
cannabis							
(meth-)amphetamines/speed							
ecstasy							
LSD							
mushrooms							
cocaine							
crack							
heroin							
sniffing							
other: _____							

(54) User: How often have you taken the following drugs in the past 30 days?

	not at all	on 1 day	on 2-5 days	on 6-9 days	on 10-19 days	on 20-30 days
cannabis						
(meth-)amphetamines/speed						
ecstasy						
LSD						
mushrooms						
cocaine						
crack						
heroin						
sniffing						
other: _____						

Control: How often have you drank alcohol in the past 30 days?

- ❍ not at all
- ❍ on 1 day
- ❍ on 2-5 days
- ❍ on 6-9 days
- ❍ on 10-19 days
- ❍ on 20-30 days

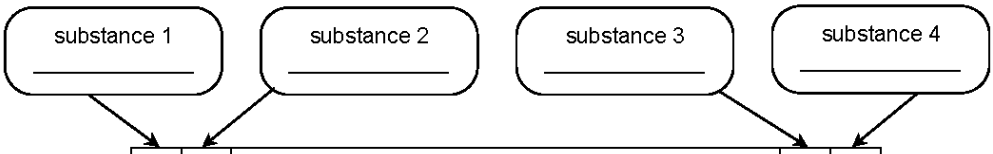
(55) User: If you've taken one of the following drugs in the past 30 days, how was the dosis per consumption unit compared to other consumers?

	smaller dose than others	normal dose	higher dose than others
cannabis (per joint, pipe...)			
(meth-)amphetamines/speed			
mushrooms			
cocaine (per "line"...)			
crack (per pipe)			
heroin			

(56) User: If you've taken one of the following drugs in the past 30 days, please state as exactly as possible how many milligrams you've taken or assess the amount on the basis of your spendings on drugs or weigh the dose at your next consumption. (1g = 1000mg).

- ❍ cannabis (per joint, pipe...): hemp _____ mg
- ❍ cannabis (per joint, pipe...): weed _____ mg
- ❍ (meth-)amphetamines/speed: _____ mg
- ❍ mushrooms: _____ mg
- ❍ cocaine (per "line"…): _____ mg
- ❍ crack (per "line"…): _____ mg
- ❍ heroin: _____ mg

(57) User: Why do you take drugs (incl. alcohol)?
Please refer to those substances you've marked in question 54 (maximum 4) and check the two most applying reasons for each substance.



		1	to have fun	1		
		2	against boredom	2		
		3	to be more powerful	3		
		4	to relax	4		
		5	to experience a sense of community	5		
		6	to experience a good physical feeling	6		
		7	to forget problems	7		
		8	to feel better	8		
		9	to overcome my restraints in social contexts	9		
		10	by habit	10		
		11	I had a great craving	11		

(58) User: How problematic is your consumption in your opinion?

	not at all	very little	little	medium	much	very much
	0	1	2	3	4	5
alcohol						
cannabis						
(meth-)amphetamines/speed						
ecstasy						
LSD						
mushrooms						
cocaine						
crack						
heroin						
sniffing						
other: _____						

Control: How problematic is your alcohol consumption in your opinion?

- ❍ not at all
- ❍ very little
- ❍ little
- ❍ medium
- ❍ much
- ❍ very much

(59) User: How much, in euros, do you spend on drugs per month (without alcohol!)?

_____ euros

(60) Imagine a period of 10 Friday evenings and 10 Saturday evenings. On how many of those 20 days do you drink notedly more than usual on weekends?

on _____ days

(61) On how many days do you drink a regular amount?

on _____ days

(62) And finally: On how many days do you not drink any alcohol?

on _____ days

(Please pay attention that the sum of the three previous statements results in 20 days!)

(63) If you drink „regular“ on a Friday or Saturday evening, how much do you drink? Please, specify beer and wine in litres and liquor (or mixed drinks) in glasses.

_____ litres of beer
○ and ○ or _____ litres of wine
○ and ○ or _____ glasses of liquor

(64) If you drink „notedly more than usual on weekends“ on a Friday or Saturday evening, how much beer, wine and liquor do you drink?

_____ litres of beer
○ and ○ or _____ litres of wine
○ and ○ or _____ glasses of liquor

(65) Imagine an average or typical week. On how many of the five days from Sunday to Thursday do you drink alcohol?

on _____ days

(66) If you drink alcohol during the week, how much beer, wine and liquor do you drink?

_____ litres of beer
○ and ○ or _____ litres of wine
○ and ○ or _____ glasses of liquor

(67) In general, have you ever drink-driven with less than 0.05% BAC?

❍ yes ❍ no

(68) If yes, how often did you drive drunk with less than 0.05% BAC in the past 30 days?

_____ number of days drunk-driving **(< 0.05% BAC)**

(69) In general, have you ever drink-driven with more than 0.05% BAC?

❍ yes, how often approx.? _____ ❍ no

(70) If yes, did you drive drunk mainly in town or out of town?

- ❍ in town
- ❍ out of town
- ❍ don't know

(71) If yes, how many kilometres did you drive drunk?

❍ km: _____ ❍ don't know

(72) If yes, how much had you drunk at that time? (If you were driving more than once with more than 0.05% BAC, please state the most you've ever drunk.)

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

❍ don't know

(73) How often did you drive drunk with more than 0.05% BAC in the past 30 days?

_____ number of days drunk-driving **(> 0.05% BAC)**

(74) In general, were you ever driving under the influence of one of the substances named above (except alcohol)?

❍ yes, under the influence of _____
how often approximately? _____

❍ no

(75) User: If yes, how often did you drive under the influence of one of the substances named above in the past 30 days (except alcohol)?

____ number of days under the influence of drugs (namely under _____)

(76) User: Did you take any drug combinations (incl. alcohol) in the past 30 days?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:___
1											
2											
3											
4											
5											

❍ no

(77) User: In former times, did you take any drug combination not named in question (76) (incl. alcohol)?

Control: In former times, did you take any drug combination (incl. alcohol)?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:___
1											
2											
3											
4											
5											

❍ no

(78) User: Did you drive under the influence of a drug combination (incl. alcohol) in the past 30 days?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other:___
1											
2											
3											
4											
5											

❍ no

(79) User: In former times, did you drive under the influence of any drug combination not named in question (78) (incl. alcohol)?

Control: In former times, did you drive under the influence of a drug combination (incl. alcohol)?

❍ yes, namely the following combination(s) of drugs:

combination	alcohol	cannabis	amph./speed	ecstasy	LSD	mushrooms	cocaine	crack	heroin	sniffing	other ___
1											
2											
3											
4											
5											

❍ no

(80) If you were ever driving under the influence of drugs, did you drive mainly in or out of town?

❍ in town
❍ out of town
❍ don't know

(81) If you were ever driving under the influence of drugs, how many kilometers did you drive on average?

❍ km: _____ ❍ don't know

(82) How bad or condemnable do you take driving under the influence of drugs (incl. alcohol)?

	not bad at all very bad
1 beer	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
more than 4 beers	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
cannabis	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
stimulants (e.g. amph.,speed)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
ecstasy	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
hallucinogens (e.g. LSD, mushrooms)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
cocaine	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
opiates (heroin and others)	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10
sedatives	0 .. 1 .. 2 .. 3 .. 4 .. 5 .. 6 .. 7 .. 8 .. 9 .. 10

(83) Under which of the following substance would you never drive, regardless if you've already taken it or not?
(Multiple answers possible!)

- ❍ 1 beer
- ❍ more than 4 beers
- ❍ cannabis
- ❍ stimulants (e.g. amph.,speed)
- ❍ ecstasy
- ❍ hallucinogens (e.g. LSD, mushrooms)
- ❍ cocaine
- ❍ opiates (heroin and others)
- ❍ sedatives
- ❍ I'd drive under all of these substances.
- ❍ I'd drive under none of these substances.

(84) Do you take driving under the influence of a combination of drugs more dangerously than driving under the influence of just one substance (incl. alcohol)?

- ❍ yes, more dangerous
- ❍ no, no more dangerous

(85) In your opinion, how common is driving under the influence of the following substances?

	not at all 0	very little 1	little 2	medium 3	much 4	very much 5
1 beer						
more than 4 beers						
cannabis						
stimulants (e.g. amph.,speed)						
ecstasy						
hallucinogens (e.g. LSD, mushrooms)						
cocaine						
opiates (heroin and others)						
sedatives						

(86) User: How much does your decicion to drive or not to drive after the consumption of drugs (incl. alcohol) depend on the following points?

	not at all 0	very little 1	little 2	medium 3	much 4	very much 5
(on the consumption / on the effects …)						
…how much I've taken						
…when I've taken the drug						
…which drug/combination of drugs I've taken						
…how roadworthy/tired I feel						
(on possible alternatives…)						
…whether I have money for a taxi or not						
…whether I can walk/take the public transport or not						

…whether I can go with someone or not						
…whether I have to be at home the next morning or whether I can sleep over or not						
…whether I need the car at home the next morning or not						
(on the route…)						
…on the kind of route (motorway, rural, city)						
…on the length of the route						
…on the level of familiarity to the route						
…on the density of controls on the route						
(social reasons…)						
…whether I have passengers who I could endanger or not						
…whether I should take somebody home or not						
…whether it bothers my passengers or not						
…how sober I am compared to other potential drivers						

(87) How often do you go out on average (meet friends, party, disco, bar)?

- ❍ 5-7 times per week
- ❍ 3-4 times per week
- ❍ 1-2 times per week
- ❍ 1-3 times per month
- ❍ less frequently

(88) How much beer, wine or liquor does your father drink on a usual Saturday evening?

○ and ○ or ____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

- ❍ don't know

(89) How much beer, wine or liquor does your mother drink on a usual Saturday evening?

○ and ○ or ____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor

- ❍ don't know

(90) If you have a permanent partner, does he or she take drugs?

- ❍ yes, so-called „soft" drugs (cannabis)
- ❍ yes, so-called „hard" drugs (amphetamines, opiates, cocaine)
- ❍ yes, so-called „soft" and „hard" drugs
- ❍ no, my partner doesn't take drugs
- ❍ I have no permanent partner.

(91) How many of your friends, with whom you have regular contact, take so-called „soft" drugs (cannabis)?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(92) How many of your friends, with whom you have regular contact, take so-called „hard" drugs (amphetamines, opiates, cocaine)?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(93) How many of your friends, with whom you have regular contact, take illegal drugs and drive afterwards?

- ❍ no one
- ❍ few
- ❍ about the half
- ❍ many

(94) User: What do your friends think about your consumption of illegal drugs?

Controls: If you consumed illegal drugs, what would your friends think about?

it doesn't bother them	0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 10	they extremely disapprove it

(95) Assume that you are driving after the intake of the following substances, how would your friends react if they found out?

	it wouldn't bother them										they would react very disapproved
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(96) „If I know the driver had taken the following substances, I don't go with him." To what extent do you agree to this statement?

	don't agree										completely agree
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(97) Do you like the prohibition of alcohol for novice drivers in their probationary period and for under 21-year-olds, which was introduced on August 1st 2007?

- ❍ yes, it was high time, better would be 0.00% for everyone
- ❍ yes, I am in favour of it, it is safer
- ❍ I really don't care
- ❍ no, I don't like it, one beer should be permitted

(98) For cannabis, should there be a threshold concerning the substance level in the blood – similar to alcohol - under which you are allowed to drive (in contrast to the current applied zero-tolerance rule)?

- ❍ yes
- ❍ no
- ❍ don't know

reason: _____

(99) User: How many euros penalty will definitely restrain you from driving under the influence of illegal drugs?

- ❍ as of 100 €
- ❍ as of 500 €
- ❍ as of 1,000 €
- ❍ as of 3,000 €
- ❍ not at all, I'd drive at all times
- ❍ I never drive under the influence of illegal drugs

(100) How often have you roughly been stopped by the police since you possess your driving licence?

about _____ times

(101) How often were you tested for alcohol by the police?

about _____ times

(102) How often were you tested for illegal drugs?

about _____ times

(103) How often were you stopped by the police in the last two years?

about _____ times

(104) Have you ever been stopped and caught by the police under the influence of alcohol (>0.05% BAC) or illegal drugs?

- ❍ yes, _____ times
  namely under the influence of _____
- ❍ no

(105) Have you ever been stopped by the police under the influence of alcohol (>0.05% BAC) or illegal drugs without the police noticing the influence?

- ❍ yes, _____ times
  namely under the influence of _____
- ❍ no

(106) Which blood alcohol limit do you believe to be right?

- ❍ 0.00
- ❍ 0.05
- ❍ 0.08
- ❍ other: _____

(107) What do you think you are allowed to drink to reach 0.1% BAC? Please estimate the amount on the drink you drink most.

	____ litres of beer
○ and ○ or	____ litres of wine
○ and ○ or	____ glasses of liquor

❍ don't know

(108) How much alcohol would you drink at maximum to drive still safely? Please estimate the amount on the drink you drink most.

____ litres of beer
○ and ○ or ____ litres of wine
○ and ○ or ____ glasses of liquor
❍ don't know

(109) Someone drinks beer with his meal and drives afterwards. Should that be allowed?

no, I'm strictly against — 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 — yes, this should really be allowed

(110) In the following question you should estimate the risk of getting stopped by the police on different routes at different times. Please assume you are driving a five year old VW Golf without attracting attention.

How do you estimate the probability of getting caught by the police on the following routes at the stated times

?	don't know
1	**VERY UNLIKELY** nearly to exclude, that ought to be a mischance
2	**UNLIKELY** but cannot be excluded
3	**LIKELY** definitely within the realms of possibility
4	**VERY LIKELY** if the police are checking today, than here and now – better to take a taxi

ON WORKING DAYS

route · region	within city	within outskirt	city <->outskirt	just across country
route · distance	<3km	<3km	<10km	>10km
route · example	Boot -> L music club	innerhalb Lengfeld	Innenstadt <-> Lengfeld	Uettingen -> Marktheidenfeld
time · 06am-12am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 12am-08pm	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 08pm-02am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 02am-06am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4

WEEKEND

route · region	within city	within outskirt	city <->outskirt	just across country
route · distance	<3km	<3km	<10km	>10km
route · example	Boot -> L music club	innerhalb Lengfeld	Innenstadt <-> Lengfeld	Uettingen -> Marktheidenfeld
time · 06am-12am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 12am-08pm	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 08pm-02am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4
time · 02am-06am	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4	? 1 2 3 4

(111) Someone drives under the influence of one of the following drugs and gets into a police stop. Do the police notice in a sobriety roadblock that the driver is under the influence of drugs?

	definitely not										definitely
1 beer	0	1	2	3	4	5	6	7	8	9	10
more than 4 beers	0	1	2	3	4	5	6	7	8	9	10
cannabis	0	1	2	3	4	5	6	7	8	9	10
stimulants (e.g. amph.,speed)	0	1	2	3	4	5	6	7	8	9	10
ecstasy	0	1	2	3	4	5	6	7	8	9	10
hallucinogens (e.g. LSD, mushrooms)	0	1	2	3	4	5	6	7	8	9	10
cocaine	0	1	2	3	4	5	6	7	8	9	10
opiates (heroin and others)	0	1	2	3	4	5	6	7	8	9	10
sedatives	0	1	2	3	4	5	6	7	8	9	10

(112) User: Have you ever thought about ceasing or restricting the consumption of one of the drugs you take (incl. alcohol)?
(In every answer several substances can be named!)

- ❍ Yes, I seriously consider ceasing the consumption of the following substance(s) within the next 6 months: _____
- ❍ Yes, it is my intention to stop the consumption of the following substance(s), but not within the next 6 months (but later): _____
- ❍ Yes, it is my intention to restrict my consumption of the following substance(s): _____
- ❍ No, I neither want to cease nor restrict my consumption.

(113) User: If you would like to stop the consumption of illegal drugs, for which reasons you would do it? *(Please, check <u>two</u> at maximum!)*

Controls: Why don't you take drugs? *(Please, check <u>two</u> at maximum!)*

- ❍ (1) for fear of penalty/legal consequences
- ❍ (2) it's to expensive
- ❍ (3) because my friends don't take drugs, too
- ❍ (4) because I can have fun without drugs
- ❍ (5) because other things became more important to me
- ❍ (6) for fear not to get my life on track
- ❍ (7) for fear of getting/being addicted
- ❍ (8) for fear of harmful effects
- ❍ (9) for fear/because of unpleasant side-effects of the drug
- ❍ (10) due to family reasons (parents, partner, relationship, pregnancy...)
- ❍ (11) other: _____
- ❍ (12) I don't want to stop.

YET ANOTHER FOUR DIFFERENT QUESTIONS...

(114) How satisfied are you with your personal life situation on the whole?

totally dissatisfied 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 totally satisfied

(115) To what extent do you agree to the following statement: „If a constitutional state should work, all laws have to be observed strictly!"?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

(116) To what extent do you agree to the following statement: „I try to live on healthy food.“?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

(117) To what extent do you agree to the following statement: „Someone who is always occupied with his health has no fun.“?

don't agree 0 ..... 1 ..... 2 ..... 3 ..... 4 ..... 5 ..... 6 ..... 7 ..... 8 ..... 9 ..... 10 completely agree

17.3 Q-Daily-Questionnaire

Table 103: Questions and response options of the daily questionnaire that was deployed on the smartphones (serial number, data level, question number and number of response options).

Serial number	Level	Question number	Response number	Question	Response option
1	Day	1	1	For which day do you fill in the questionnaire?	date
2	Day	2	1	When did you wake up today?	time
3	Day	3	1	How long did you sleep?	0 - 14/> 14
4	Day	4	1	How well was your sleep?	very good
5	Day	4	2		good
6	Day	4	3		medium
7	Day	4	4		bad
8	Day	4	5		very bad
9	Situation	5	1	Situation?	at home
10	Situation	5	2		friends
11	Situation	5	3		relatives
12	Situation	5	4		job
13	Situation	5	5		school
14	Situation	5	6		private business
15	Situation	5	7		culture, sports
16	Situation	5	8		restaurant, bar
17	Situation	5	9		club
18	Situation	5	10		event
19	Situation	5	11		outside
20	Situation	5	12		excursion
21	Situation	5	13		accomodation
22	Situation	5	14		miscellaneous response
23	Situation	6	1	from…	time
24	Situation	7	1	to…	time
25	Drug	8	1	Did you take drugs/medicines in this situation?	yes
26	Drug	8	2		no
27	Drug	9	1	Which sort of drugs did you take?	alcohol
28	Drug	9	2		cannabis
29	Drug	9	3		amphetamine
30	Drug	9	4		ecstasy
31	Drug	9	5		LSD
32	Drug	9	6		mushrooms
33	Drug	9	7		cocaine, crack
34	Drug	9	8		heroin
35	Drug	9	9		sniffing
36	Drug	9	10		miscellaneous response
37	Drug	10	1	How much alcohol did you drink?	beer
38	Drug	10	2		wine
39	Drug	10	3		liquor
40	Drug	10	4		miscellaneous response
41	Drug	11	1	Number of consumption units?	2cl - 7l
42	Drug	12	1	consumption from…	time
43	Drug	13	1	consumption to…	time
44	Drug	14	1	How did you consume cannabis?	joint/inhalation
45	Drug	14	2		pipe/line
46	Drug	14	3		cookie/pill
47	Drug	14	4		tea/injection
48	Drug	15	1	Number of co-consumers?	1 - 5/> 5
49	Drug	16	1	Number of consumption units?	0.5 - 5/> 5
50	Drug	17	1	consumption from…	time
51	Drug	18	1	consumption to…	time
52	Drug	19	1	How did you consume amphetamines, speed?	joint/inhalation
53	Drug	19	2		pipe/line
54	Drug	19	3		cookie/pill
55	Drug	19	4		tea/injection
56	Drug	20	1	Number of co-consumers?	1 - 5/> 5
57	Drug	21	1	Number of consumption units?	0.5 - 5/> 5
58	Drug	22	1	consumption from…	time
59	Drug	23	1	consumption to…	time
60	Drug	24	1	How much ecstasy did you take? (Number of pills)	0.5 - 5/> 5
61	Drug	25	1	consumption from…	time
62	Drug	26	1	consumption to…	time
63	Drug	27	1	How much LSD did you take? (Number of blotters)	0.5 - 5/> 5
64	Drug	28	1	consumption from…	time
65	Drug	29	1	consumption to…	time
66	Drug	30	1	How many mushrooms did you take?	< 5
67	Drug	30	2		5-10
68	Drug	30	3		10-15
69	Drug	30	4		15-20
70	Drug	30	5		20-30
71	Drug	30	6		> 30

Serial number	Level	Question number	Response number	Question	Response option
72	Drug	31	1	consumption from…	time
73	Drug	32	1	consumption to…	time
74	Drug	33	1	How did you consume cocaine/crack?	joint/inhalation
75	Drug	33	2		pipe/line
76	Drug	33	3		cookie/pill
77	Drug	33	4		tea/injection
78	Drug	34	1	Number of co-consumers?	1 - 5/> 5
79	Drug	35	1	Number of consumption units?	0.5 - 5/> 5
80	Drug	36	1	consumption from…	time
81	Drug	37	1	consumption to…	time
82	Drug	38	1	How did you consume heroin?	joint/inhalation
83	Drug	38	2		pipe/line
84	Drug	38	3		cookie/pill
85	Drug	38	4		tea/injection
86	Drug	39	1	Number of co-consumers?	1 - 5/> 5
87	Drug	40	1	Number of consumption units?	0.5 - 5/> 5
88	Drug	41	1	consumption from…	time
89	Drug	42	1	consumption to…	time
90	Drug	43	1	How much sniffing agent did you take? (Number inhalations)	0.5 - 5/> 5
91	Drug	44	1	consumption from…	time
92	Drug	45	1	consumption to…	time
93	Drug	46	1	Did you take any other drugs? If yes, what kind of drug?	miscellaneous response
94	Drug	47	1	How did you take it?	joint/inhalation
95	Drug	47	2		pipe/line
96	Drug	47	3		cookie/pill
97	Drug	47	4		tea/injection
98	Drug	47	5		drops
99	Drug	48	1	Number of co-consumers?	1 - 5/> 5
100	Drug	49	1	Number of consumption units?	0.5 - 5/> 5
101	Drug	50	1	consumption from…	time
102	Drug	51	1	consumption to…	time
103	Drug	52	1	Was the consumption planned?	planned / routine
104	Drug	52	2		spontaneous
105	Drug	53	1	Have you consumed more or less than initially thought?	more
106	Drug	53	2		normal
107	Drug	53	3		less
108	Drug	54	1	How did you feel before drug-intake?	very good
109	Drug	54	2		good
110	Drug	54	3		medium
111	Drug	54	4		bad
112	Drug	54	5		very bad
113	Drug	55	1	How did you feel after drug-intake?	very good
114	Drug	55	2		good
115	Drug	55	3		medium
116	Drug	55	4		bad
117	Drug	55	5		very bad
118	Drug	56	1	How strong was the drug effect?	very weak
119	Drug	56	2		weak
120	Drug	56	3		medium
121	Drug	56	4		strong
122	Drug	56	5		very strong
123	Companion	57	1	Were any companions present?	no
124	Companion	57	2		yes
125	Companion	58	1	How many companions were present?	1 - 5/> 5
126	Companion	59	1	Gender of companions?	male
127	Companion	59	2		female
128	Companion	60	1	Age of companions?	< 13
129	Companion	60	2		13-17
130	Companion	60	3		18-24
131	Companion	60	4		25-29
132	Companion	60	5		30-39
133	Companion	60	6		> 39
134	Companion	61	1	Did companions use drugs in this situation?	no
135	Companion	61	2		yes, alcohol
136	Companion	61	3		yes, others
137	Companion	61	4		yes, both
138	Companion	61	5		don't know
139	Trip	62	1	After the situation travelled by…	on foot
140	Trip	62	2		bicycle
141	Trip	62	3		public transport
142	Trip	62	4		taxi
143	Trip	62	5		vehicle
144	Trip	62	6		transporter
145	Trip	62	7		truck
146	Trip	62	8		moped
147	Trip	62	9		motorcycle
148	Trip	62	10		miscellaneous response
149	Trip	63	1	In the car, I was the…	passenger
150	Trip	63	2		driver

Serial number	Level	Question number	Response number	Question	Response option
151	Trip	64	1	Did you take drugs on the trip? (see situation)	no
152	Trip	64	2		yes
153	Trip	65	1	Were any companions present on the trip? (see situation)	no
154	Trip	65	2		yes
155	Trip	66	1	How long was the distance of the trip?	< 1 km
156	Trip	66	2		1-5 km
157	Trip	66	3		5-10 km
158	Trip	66	4		10-25 km
159	Trip	66	5		25-100 km
160	Trip	66	6		> 100 km
161	Trip	67	1	Was the trip planned?	planned / routine
162	Trip	67	2		spontaneous
163	Trip	68	1	Why didn't you drive by yourself?	not planned
164	Trip	68	2		previous consumption
165	Trip	68	3		later consumption
166	Trip	69	1	Was the route known?	no
167	Trip	69	2		yes
168	Trip	70	1	On what road did you drive (in %)?	city
169	Trip	70	2		rural
170	Trip	70	3		motorway
171	Trip	71	1	Was there any dangerous situation?	yes
172	Trip	71	2		no
173	Trip	72	1	How dangerous was the situation?	none
174	Trip	72	2		very little
175	Trip	72	3		little
176	Trip	72	4		medium
177	Trip	72	5		much
178	Trip	72	6		very much
179	Trip	73	1	How well/safe did you drive?	very good
180	Trip	73	2		good
181	Trip	73	3		medium
182	Trip	73	4		bad
183	Trip	73	5		very bad
184	Trip	74	1	How trying was the journey?	none
185	Trip	74	2		very little
186	Trip	74	3		little
187	Trip	74	4		medium
188	Trip	74	5		much
189	Trip	74	6		very much
190	Trip	75	1	How tired have you been while driving?	none
191	Trip	75	2		very little
192	Trip	75	3		little
193	Trip	75	4		medium
194	Trip	75	5		much
195	Trip	75	6		very much
196	Trip	76	1	Did you take drugs before or during this trip?	no, no consumption intended
197	Trip	76	2		yes, consumption
198	Trip	76	3		no, abdication
199	Trip	76	4		yes, restriction
200	Trip	77	1	How impaired have you felt by the drugs?	none
201	Trip	77	2		very little
202	Trip	77	3		little
203	Trip	77	4		medium
204	Trip	77	5		strong
205	Trip	77	6		very strong
206	Trip	78	1	Did you change your driving behaviour because of the drugs?	no
207	Trip	78	2		yes, other route
208	Trip	78	3		yes, more careful
209	Trip	78	4		yes, later
210	Trip	78	5		yes, more conform
211	Trip	79	1	Today, you were driving by yourself and stated to have refrained from / restricted drug consumption therefore. Please note, in which situations that was the case.	yes
212	Trip	79	2		no
213	Trip	80	1	Did the driver consume drugs?	yes
214	Trip	80	2		no
215	Trip	80	3		don't know
216	Trip	81	1	Which drugs did the driver take?	no drugs
217	Trip	81	2		alcohol
218	Trip	81	3		cannabis
219	Trip	81	4		amphetamine
220	Trip	81	5		ecstasy
221	Trip	81	6		LSD
222	Trip	81	7		mushrooms
223	Trip	81	8		cocaine/crack
224	Trip	81	9		heroin
225	Trip	81	10		sniffing
226	Trip	81	11		miscellaneous response
227	Trip	82	1	What was the age of the driver?	<21
228	Trip	82	2		>20

Serial number	Level	Question number	Response number	Question	Response option
229	Trip	83	1	Does the driver have his license on probation?	yes
230	Trip	83	2		no
231	Trip	83	3		don't know
232	Trip	84	1	Did the driver drink more than one beer/wine?	yes
233	Trip	84	2		no
234	Day	85	1	Was the day in any way uncharacteristic for you?	no, normal
235	Day	85	2		holiday
236	Day	85	3		illness
237	Day	85	4		higher consumption
238	Day	85	5		less consumption
239	Day	85	6		higher mobility
240	Day	85	7		less mobility
241	Day	85	8		international journey
242	Day	85	9		domestic journey
243	Day	85	10		miscellaneous response
244	Day	86	1	How much occupational stress did you have today?	none
245	Day	86	2		very little
246	Day	86	3		little
247	Day	86	4		medium
248	Day	86	5		much
249	Day	86	6		very much
250	Day	87	1	How much private stress did you have today?	none
251	Day	87	2		very little
252	Day	87	3		little
253	Day	87	4		medium
254	Day	87	5		much
255	Day	87	6		very much
256	Day	88	1	In which mood have you been today?	very good
257	Day	88	2		good
258	Day	88	3		medium
259	Day	88	4		bad
260	Day	88	5		very bad
261	Day	89	1	How active did you feel today?	none
262	Day	89	2		very little
263	Day	89	3		little
264	Day	89	4		medium
265	Day	89	5		much
266	Day	89	6		very much
267	Day	90	1	How much tired have you felt today?	none
268	Day	90	2		very little
269	Day	90	3		little
270	Day	90	4		medium
271	Day	90	5		much
272	Day	90	6		very much
273	Day	91	1	How was your health today?	very good
274	Day	91	2		good
275	Day	91	3		medium
276	Day	91	4		bad
277	Day	91	5		very bad
278	Day	92	1	What were the road conditions today?	dry
279	Day	92	2		wet
280	Day	92	3		aquaplan
281	Day	92	4		slushy
282	Day	92	5		slick
283	Day	92	6		snow
284	Day	93	1	Why didn't you take drugs today?	no need
285	Day	93	2		reduction
286	Day	93	3		want be fit
287	Day	93	4		must be fit
288	Day	93	5		not available
289	Day	93	6		miscellaneous response
290	Day	94	1	Do you intend to take drugs tomorrow?	yes
291	Day	94	2		rather yes
292	Day	94	3		rather no
293	Day	94	4		no
294	Day	94	5		don't know

17.4 THC elimination curve

Table 104: THC elimination curve by Sticht (G. Sticht, personal communication, December 2009).

Elimination time (hh:mm:ss)	ng/ml per mg smoked THC	Elimination time (hh:mm:ss)	ng/ml per mg smoked THC
00:15:00	3.143	06:15:00	0.084
00:30:00	1.440	06:30:00	0.077
00:45:00	0.833	06:45:00	0.070
01:00:00	0.627	07:00:00	0.064
01:15:00	0.536	07:15:00	0.058
01:30:00	0.479	07:30:00	0.053
01:45:00	0.435	07:45:00	0.049
02:00:00	0.396	08:00:00	0.044
02:15:00	0.361	08:15:00	0.041
02:30:00	0.329	08:30:00	0.037
02:45:00	0.301	08:45:00	0.034
03:00:00	0.275	09:00:00	0.031
03:15:00	0.251	09:15:00	0.028
03:30:00	0.229	09:30:00	0.025
03:45:00	0.209	09:45:00	0.023
04:00:00	0.191	10:00:00	0.021
04:15:00	0.174	10:15:00	0.019
04:30:00	0.159	10:30:00	0.018
04:45:00	0.145	10:45:00	0.016
05:00:00	0.133	11:00:00	0.015
05:15:00	0.121	11:15:00	0.013
05:30:00	0.110	11:30:00	0.013
05:45:00	0.101	11:45:00	0.011
06:00:00	0.092	12:00:00	0.010

17.5 Consumption on previous day

Table 105: Percentage of drives that were positive for cannabis and/or alcohol with (same day) and without (previous day) previous consumption on same day.

Time	Consumption on previous day	Consumption on same day
5	4.26%	95.74%
6	52.22%	47.78%
7	57.01%	42.99%
8	63.96%	36.04%
9	62.96%	37.04%
10	50.91%	49.09%
11	35.14%	64.86%
12	28.42%	71.58%
13	23.48%	76.52%
14	21.58%	78.42%
15	14.71%	85.29%
16	8.81%	91.19%
17	5.05%	94.95%
18	3.15%	96.85%
19	2.30%	97.70%
20	2.15%	97.85%
21	1.15%	98.85%
22	2.00%	98.00%
23	0.29%	99.71%
24	0.97%	99.03%
1	0.99%	99.01%
2	6.40%	93.60%
3	0.00%	100.00%
4	1.39%	98.61%

17.6 Confidence intervals for BAC- / THC-positive drives

Table 106: Confidence intervals (±0.95 CI) for BAC-positive drives within the sample of users (N_{User}=195) and of controls ($N_{Control}$=100) for the age groups 18-24 and 25-39.

BAC (in %)	18-24 Control	18-24 User	25-39 Control	25-39 User
≥0.01	0.42% - 2.34%	3.62% - 6.97%	1.61% - 4.88%	3.66% - 7.53%
≥0.02	0.23% - 2.08%	3.07% - 6.28%	0.81% - 3.51%	2.89% - 6.27%
≥0.03	0.02% - 1.75%	2.34% - 5.48%	0.36% - 2.28%	1.94% - 5.08%
≥0.04	-	1.95% - 4.8%	0.06% - 1.77%	1.4% - 4.26%
≥0.05	-	1.6% - 4.37%	-	0.99% - 3.82%
≥0.06	-	1.28% - 3.81%	-	0.82% - 3.12%
≥0.07	-	1.05% - 3.51%	-	0.63% - 2.41%
≥0.08	-	0.9% - 3.14%	-	0.45% - 2.09%
≥0.09	-	0.73% - 2.71%	-	0.25% - 1.66%
≥0.10	-	0.56% - 2.43%	-	0.16% - 1.36%
≥0.11	-	0.49% - 2.23%	-	0.09% - 1.24%
≥0.20	-	0.15% - 1.37%	-	-

Table 107: Confidence intervals (±0.95 CI) for THC-positive drives within the sample of users (N_{User}=195) for the age groups 18-24 and 25-39.

THC blood plasma level (in ng/ml)	18-24	25-39
≥1	11.7% - 18.97%	8.84% - 18.93%
≥2	9.43% - 15.71%	6.63% - 15.85%
≥3	7.91% - 13.67%	5.35% - 13.82%
≥4	6.75% - 12.09%	4.46% - 12.58%
≥5	5.58% - 10.37%	3.82% - 11.55%
≥6	4.93% - 9.4%	3.47% - 10.91%
≥7	4.25% - 8.11%	3.06% - 10.28%
≥8	3.8% - 7.36%	2.54% - 9.41%
≥9	3.56% - 6.89%	2.38% - 9.01%
≥10	3.1% - 6.28%	1.99% - 8.4%
≥20	1.14% - 2.55%	0.84% - 5.3%
≥40	0.21% - 0.84%	0.07% - 2.33%

17.7 ART2020 failure rates

Table 108: ART2020 failure rates for cannabis intoxicated users ($N_{AcuteCann}$=16) and users who were not under influence ($N_{NoAcuteCann}$=48) as well as controls ($N_{Controls}$=42) and users with light ($N_{LightUse}$=46) or heavy lifetime drug use ($N_{HeavyUse}$=18).

Failure rate					
Test/Parameter	**$Perc_{AcuteCann}$**	**$Perc_{NoAcuteCann}$**	**$Perc_{HeavyUse}$**	**$Perc_{LightUse}$**	**$Perc_{Control}$**
ART	68.8%	58.3%	61.1%	63%	69%
MAT	0%	0%	0%	0%	0%
Correct responses	0%	0%	0%	0%	0%
Q1	37.5%	20.8%	16.7%	23.9%	16.7%
Processed items	0%	0%	0%	0%	0%
% Errors	37.5%	20.8%	16.7%	23.9%	16.7%
LL5	0%	6.3%	5.6%	4.3%	7.1%
Processed items	0%	0%	0%	0%	0%
% Errors	0%	6.3%	5.6%	4.3%	7.1%
GEMAT3	6.3%	0%	0%	0%	0%
Correct responses	6.3%	0%	0%	0%	0%
PVT	18.8%	37.5%	50%	32.6%	31%
Mean reaction time	12.5%	14.6%	22.2%	10.9%	16.7%
Mean reaction time - left	12.5%	16.7%	22.2%	10.9%	19%
Mean reaction time - right	0%	14.6%	22.2%	15.2%	14.3%
Mean tracking deviation	12.5%	22.9%	33.3%	19.6%	11.9%
SENSO	31.3%	31.3%	38.9%	28.3%	38.1%
Time – phase 1	0%	0%	0%	0%	0%
Time big errors – phase 1	0%	10.4%	11.1%	8.7%	16.7%
Time small errors – phase 1	0%	8.3%	11.1%	4.3%	7.1%
Number big errors – phase 1	0%	8.3%	5.6%	8.7%	9.5%
Number small errors – phase 1	6.3%	4.2%	5.6%	4.3%	0%
Time big errors – phase 2	0%	2.1%	0%	2.2%	4.8%
Time small errors – phase 2	6.3%	2.1%	5.6%	0%	4.8%
Number big errors – phase 2	0%	2.1%	0%	0%	2.4%
Number small errors – phase 2	0%	2.1%	0%	4.3%	2.4%
Time – phase 3	0%	0%	0%	2.2%	0%
Time big errors – phase 3	18.8%	14.6%	27.8%	10.9%	11.9%
Time small errors – phase 3	0%	10.4%	11.1%	8.7%	14.3%
Number big errors – phase 3	0%	10.4%	22.2%	8.7%	14.3%
Number small errors – phase 3	6.3%	8.3%	0%	10.9%	4.8%
Total time	0%	0%	0%	0%	0%
Total time big errors	0%	10.4%	11.1%	6.5%	7.1%
Total time small errors	0%	4.2%	5.6%	2.2%	4.8%
RST3	25%	8.3%	11.1%	10.9%	19%
Correct responses – phase 1	0%	4.2%	5.6%	4.3%	0%
% Delayed reactions – phase 1	0%	2.1%	0%	4.3%	4.8%
Omissions – phase 1	0%	2.1%	5.6%	2.2%	0%
% Errors – phase 1	12.5%	0%	5.6%	0%	4.8%
Correct responses – phase 2	6.3%	2.1%	11.1%	0%	0%
% Delayed reactions – phase 2	0%	0%	0%	0%	0%
Omissions – phase 2	0%	2.1%	5.6%	0%	0%
% Errors – phase 2	0%	2.1%	5.6%	4.3%	2.4%
Correct responses – phase 3	0%	2.1%	5.6%	2.2%	2.4%
% Delayed reactions – phase 3	0%	0%	0%	0%	7.1%
Omissions – phase 3	0%	2.1%	5.6%	2.2%	7.1%
% Errors – phase 3	12.5%	0%	5.6%	2.2%	2.4%